

**RECORDS OF THE
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Indian Seashells

(Part-1)

POLYPLACOPHORA AND GASTROPODA

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Edited by the Director, Zoological Survey of India, Kolkata



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FOREWORD

Taxonomical study is the corner stone at the Zoological Survey of India. One of its primary objectives is to survey, identify and prepare an inventory of faunal diversity in India. During this process it has built up strong capabilities in several groups. Mollusca is one such group. Since its inception in 1916 the Survey has assiduously cultivated a rich tradition in the field of malacology.

Agenda 21 of Convention on Biodiversity stresses the need for conservation of marine coastal habitats. Marine biomes have become priority areas for conservation. Zoological Survey of India has been focussing its attention on biodiversity and it is in the process of strengthening marine research in the country. The large coastline and the vast Exclusive Economic Zone of India offer ideal habitats for molluscs. They commonly occur in all the four major coral reef areas and rocky coasts of India. Molluscs constitute about 30 percent of marine faunal diversity in India. There is a need to develop a good taxonomic database on marine biodiversity. It is often heard that lack of readily available literature discourages a student to opt for Taxonomy. I am glad that ZSI is partly fulfilling one of its primary objectives by publishing this book on Indian Seashells. A ready reference book like this, I hope, would catalyze the study of molluscs in India.

Mollusca is too large a phylum to deal with in one single volume. The present volume, therefore, is devoted to only two classes namely, Polyplacophora and Gastropoda. These together account for 20 percent of faunal species estimated to occur in the marine ecosystems of India. About 530 species belonging to 80 families are dealt in this book. This is the first book of its kind on Indian molluscs.

The author of this book is a well-known malacologist with four decades of research background in molluscs. He had already contributed a volume on Freshwater Molluscs of India. The present book will go a long way in meeting the demand in India and abroad for an authentic taxonomic study on marine molluscs of India. I hope and believe that this book, Indian Seashells 1. Polyplacophora and Gastropoda, will serve as a valuable reference book for students of Indian universities and all those interested in the study of molluscs.

Dr. J. R. B. Alfred
Director
Zoological Survey of India

PREFACE

The phylum Mollusca is very large consisting of thousands of species commonly known as shells. This numerically abundant and common biota of seas around India has not received any special treatment and no single comprehensive volume is available on marine molluscs of India. There are however, a few publications on the regional molluscs, especially of southeast coast of India that deal with only a few species. At the current level of interest in marine biodiversity there is a need for a ready reference book on Mollusca. This prompted the author to undertake the task of preparing a volume on marine molluscs of India. Initially it was contemplated to deal with some common marine molluscs in a single volume. Since the utility of such a book will be very much limited, it was subsequently planned to include as many species as possible to help a serious worker in identifying his or her collections. But as the work progressed it was seen that it would not be possible to do justice for all classes of Mollusca in a single volume. It was therefore decided to deal with two classes namely, Polyplacophora (Chitons) and Gastropoda (Snails and Slugs) in this volume. There are several species reported from India whose identity has to be confirmed to make the list up to date. In many cases it became a time consuming exercise, as there are no revisionary studies on Indian molluscs.

The first two chapters provide general background information on the phylum Mollusca such as classification, general organization, abundance, distribution, size and diversity. The values of molluscan diversity are explained bringing out their importance as objects of aesthetic, commercial, food and biomedical nature and role in marine biodeterioration. The references at the end of the chapter would provide additional information and help in further research. Thus the format of the book has been so devised to facilitate both a beginner and also a serious worker with some knowledge of Mollusca.

Chapter 3 deals with the Systematic Account of Polyplacophora and Gastropoda consisting of as many as 530 species belonging to 80 families. Under each Class and Family and some subfamilies important diagnostic characters are given. Each species is described giving salient shell characters and also illustrated so as to facilitate easy identification. Based on the collections available and also literature records, distribution of each species in India and elsewhere given. When a species is known to occur at many localities only the name of state is mentioned. Wherever possible additional information on the status, habitat etc. of the species are indicated. At the end of some families a few important references are cited.

Although all the references are not available to the author, a selected bibliography is given containing references on marine molluscs of India and also revisionary works of Indo-Pacific molluscs which also reflect the past and current level of interest in molluscs of India.

In accordance with the objective of this book to give a over-view of Indian sea shells, in addition to common molluscs, a few of the families, which are less known from India, such as Dialidae, Pyramidellidae, Turridae etc. are also dealt with. As far as possible names of several species reported from India are up-dated. Some species are reported herein for the first time from India.

The book of this nature has to base essentially on collections for descriptions and illustrations. The rich National Zoological Collection were made available to me through the kind courtesy of Director, Zoological Survey of India. I am obliged to Dr. J. R. B. Alfred, Director, Zoological Survey of India for the facilities and encouragement. I owe special thanks to my colleagues in the Malacology Division, Mr. K. V. Surya Rao, Scientist- SE (Retired), Mr. S. C. Mitra, Officer-in-charge of Mollusca Section, Dr. A. Dey and Mr. S. Barua and other friends. My special thanks are due to the Ministry of Environment and Forests, Government of India for the sanction of Emeritus Scientist Scheme under which major part of this work was completed. My good friend Mr. Fred Pinn, London, who started as an amateur shell collector and later turned into a serious malacologist, gave me some important photographs. Prof. A. V. Raman, Department of Zoology, Andhra University readily gave me his collections and photographs of molluscs from Visakhapatnam coast. Dr. D. R. K. Sastry, Officer-in-charge, Andaman & Nicobar Regional Station, Zoological Survey of India, has assisted me in editing the manuscript. I owe a deep sense of gratitude to all these and many other friends who helped me in the preparation of this book.

In the preparation of this book I owe an intellectual debt to several malacologists from whose publications I have drawn some general information. The publications by Dr. K. J. Boss, Dr. W. O. Cernohorsky provided some useful data. Dr. R. N. Kilburn, Natal Museum, South Africa gave me useful hints on the family Turridae, which is less known in India. I am very much obliged to them. They are however, not responsible for lapses if any in the presentation of data.

My thanks are due to Dr. W. F. Ponder, Western Australian Museum, Sydney; Dr. A. R. Kabat, Museum of Comparative Zoology, Harvard; Dr. R. G. Moolenbeek, Amsterdam; Dr. A. J. Kohn, University of Washington for sparing me their valuable reprints: to Dr. K. V. Lakshminarayana (Now Retired), Southern Regional Station, Zoological Survey of India, Chennai, and Dr. K. Venkataraman, Andaman & Nicobar Regional Station, Port Blair, now at Marine Biological Station, Chennai for their help and various courtesies in the preparation of this book.

My special thanks are due to Mr. A. Simhachalam, who assisted me in making the manuscript and plates press-ready, to Mr. Rathi Ram, Publication Production Officer and the press Ms. for neatly and promptly executing the job of printing.

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1. GENERAL INTRODUCTION

The phylum Mollusca cannot be easily defined or comprehended on the basis of a single character, since there is no such easily observable character that finds expression in all the molluscs. The phylum includes an apparently heterogeneous assemblage of organisms (Fig. 1). An oyster looks strikingly different in structure from a squid or from a snail or slug. But all the molluscs are built on a basic organisational plan. A mollusc has to be recognised on the basis of a combination of traits or characters. Majority of the molluscs can be recognised by the shell.

The phylogeny of Mollusca has been a subject of controversy. Molluscs have been considered as derived from Platyhelminthes (Morton and Yonge 1963). Lemche (1961) considered Mollusca as a rather primitive group to be placed immediately above the Coelenterata (= Cnidaria). From molluscan-like ancestors Annelida and Arthropoda have evolved independently. According to Russell-Hunter (1968), Mollusca were directly derived from Turbellaria-like animal and had no connection with stock or stocks that gave to the annelid-arthropod phyla.

Comparative anatomical and embryological evidences suggest phylogenetic interrelationships among flatworms, molluscs, annelids and arthropods. Fossil record draws a blank as far as their interrelationships are concerned. Soft-bodied flat worms did not occur in the fossil state. Annelids were represented by a few fossils in the Precambrian period, during which no fossils of other groups were represented. The major classes of molluscs were already distinct by the Cambrian period, when the molluscan fossils were known. It is therefore inferred that the ancestral mollusc might have occurred in Precambrian period. This led some malacologists to conceptualize artificial and ancestral molluscan model or archetype. Each of the several molluscan traits as we know them to-day are combined into this archetype. The reconstruction of molluscan evolution and phylogeny has been an intellectual exercise.

Of all the invertebrate phyla, there is a striking similarity between Annelida and Mollusca. Both exhibit spiral cleavage and identical trochophore larvae. The discovery of a living monoplacophoran, *Neopilina*, in 1952, added further points in support of annelid mollusc relationship. *Neopilina* displays an apparent metameric plan of structure in the replication of its parts. This prompted some to propose that mollusc arose from annelids.

Many zoologists are of the opinion that annelids and molluscs arose from a free-living flat worm-nemertine stock (Vagvolgyi, 1967; Harry, 1969; Stasek, 1972). Their ancestor, which might have looked like a small, ciliated vermiform organism had a through gut, a trochophore-like larva and pseudometamerism. The last mentioned character had got regularized in annelids, which developed more harmonious metamerism as an adaptation to the burrowing habit.

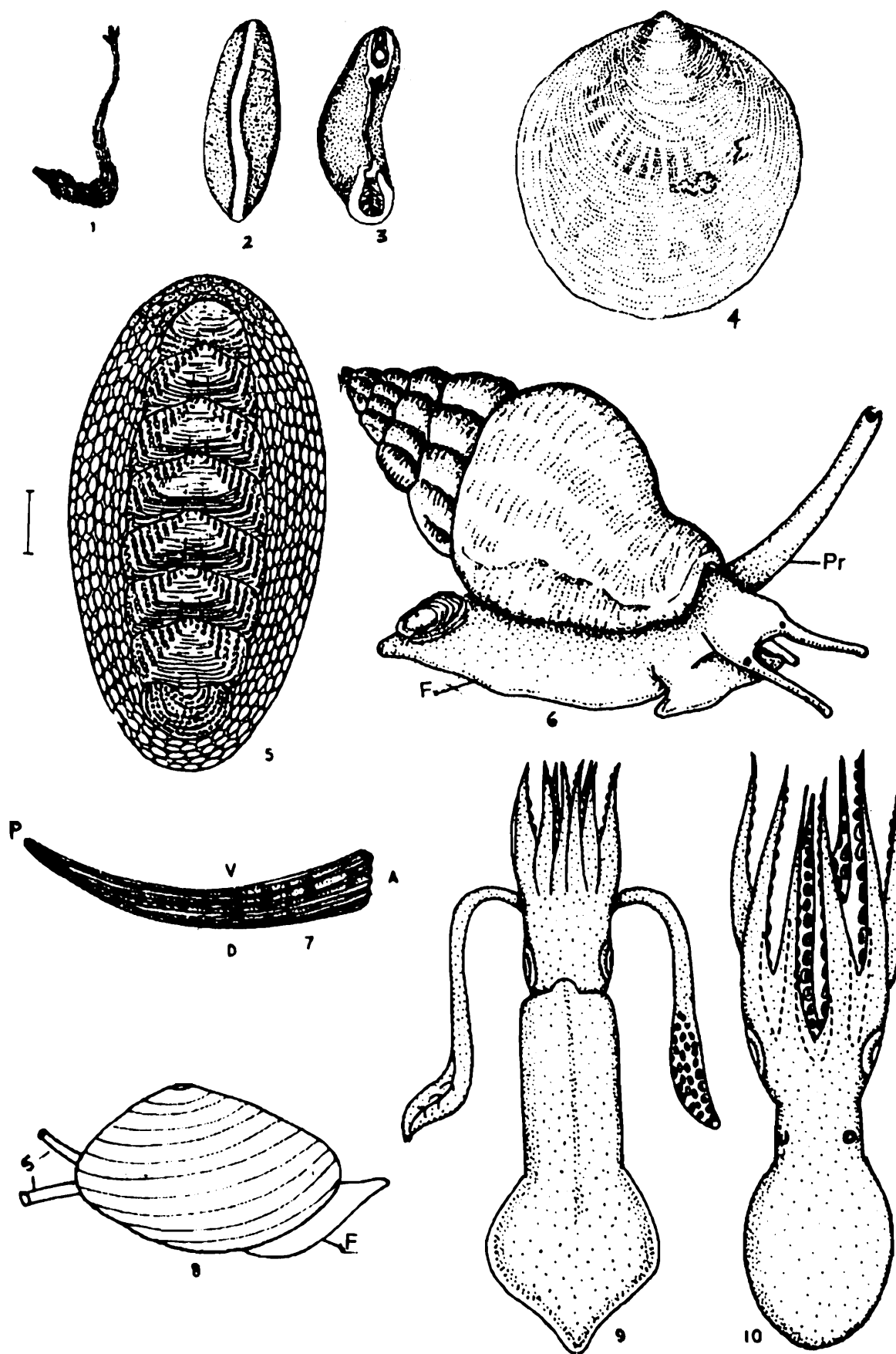


Fig. 1. Representatives of different classes of Mollusca.

1. Chaetoderma, 2 & 3. Neomenia-Aplacophora, 4. Neopilinia-Monoplacophora, 5. Chiton-Polyplacophora, 6. Gastrododa, Pr. Proboscis, F. Foot, 7. Dentalium, A. Anterior, P. Posterior, V. Ventral, D. Dorsal-Scaphopoda, 8. Bivalve, F. Foot, S. Siphon, 9. Squid, 10. Octopus-Cephalopoda.

The molluscs, however, exhibit pseudometamerism in some primitive forms, e.g. monoplacophorans and chitons but abandoned this tendency to metamerism in other classes. The two groups diverged from the common ancestor prior to the pronouncement of either molluscan or annelidan characters. Just as in the Turbellaria, molluscan foot exhibits backwardly directed waves during its locomotion. It is suggested that this rhythmic contraction of the flatworm became confined to the ventral surface of a mollusc and the dorsal parts became visceralised covered by a mantle and shell.

The theory proposed by Lang in as early as 1896, and developed recently by Stasek (1972) unfolds the molluscan framework in four stages; ancestral form, transitional turbellariform stage, transitional molluscan stage, and advanced molluscan stage.

The ancestral form was an inhabitant of the Precambrian period. It crawled about on the rocks or other hard substrate of oceans. It had a complete gut and had the ability to secrete abundant mucus, which acted as a protective cover and also as a smooth locomotory track.

In the transitional turbellariform stage, a radula and cuticle had developed. Once the skin got thickened with cuticle a ciliary respiratory mechanism had been innovated. To supply blood, a haemocoel consisting of sinuses and a dorsal heart with pericardium had come into being, the last one by modification and enlargement of the gonoducts.

The transitional molluscan stage had gills contained in an incipient mantle cavity underlying the edges of the mantle. In the advanced molluscan stage, the shell in the form of a calcified cuticle has developed dorsally; gills became pedal retractors.

Thus according to Stasek (1972) secretion of a cuticle over the dorsal body surface together with an increase in size had brought in its evolution the broad distinguishing features of the phylum Mollusca.

1.1 Classification

Linnaeus (1758) adopted the name, Mollusca, a term which was in fact proposed by Johnston (1650), but without developing any real concept of the phylum. Cuvier (1795) had shown better understanding of the group, and his concept 'approximates to modern ideas' (see Hyman, 1967 for full references). In the beginning several other groups such as barnacles, brachiopods and other shelled forms were classified together with the molluscs.

Pelseneer (1906) classified phylum Mollusca into five classes, namely Amphineura, Gastropoda, Scaphopoda, Lamellibranchia (Pelecypoda) and Cephalopoda. The present day classification is only a slight deviation and it had further split the class Amphineura.

Naef (1926) divided Mollusca into two subphyla, namely Amphineura and Conchifera, the former including Aplacophora and Polyplacophora and the latter all the other classes. At present three subphyla namely Aculifera, Placophora and Conchifera are recognised. Although there is some consensus with regards to subphyletic division there is still a difference of opinion on the

status of some classes and their division into orders. Salvini- Plawen (1969), who contributed much to the knowledge on primitive molluscs, treated Solenogastres (=Neomeniamorpha) and Caudofoveata (=Chaetodermamorpha) as two distinct classes since the two have evolved independently. But Scheltema (1978) and Ivanov (1981) are in favour of giving these two the status of subclasses under the class Aplacophora, as they had closely linked origin and the variation seen in their body plan is not sufficient enough to elevate them to the level of classes.

Based on the respiratory organs Milne Edwards (1848) divided the class Gastropoda into Prosobranchia, Opisthobranchia and Pulmonata that have been accepted traditionally. The one that was proposed by Spengel (1881) stressed the importance of the nervous system. He divided Gastropoda into Streptoneura and Euthyneura, which has been discontinued now. The euthyneurous condition of the nervous system has been attained in different ways in opisthobranchs and pulmonates. In the former it has been due to detorsion and in the latter it is the result of concentration of the anterior loop of the figure 8 into the head region. This single ring that innervated the visceral mass is in effect the posterior loop of the figure 8. Hence many malacologists have not favoured the division based on nervous system. Recently Bieler (1992) made an excellent review of the gastropod phylogeny and concluded 'any attempt to present the *classification* of Gastropoda at this point would be premature'

The two classes Scaphopoda and Cephalopoda are not subjected to many changes. Three names namely, Bivalvia, Lamellibranchia and Pelecypoda have been used for the other major class of Mollusca. The term Bivalvia was first used by Linnaeus in the 13th edition of *Systema Naturae*. It was later adopted by Hass (1929) and accepted by Newell (1969). The old term Lamellibranchia is now used to designate a subclass.

According to many malacologists Mollusca is divided into two subphyla, Aculifera and Conchifera, the former is primitive and includes Polyplacophora and Aplacophora. They have diverged much earlier in the molluscan evolution. The Conchifera includes Gastropoda, Bivalvia, Scaphopoda and Cephalopoda and have probably arisen from Monoplacophora (Runnegar and Pojeta, 1974; Yochelson, 1978).

Stasek (1972) proposed three separate lines of evolution within the phylum and distinguished three subphyla. One line i.e. Aculifera included Aplacophora, which is closest to the stem group and gave rise to Solenogastres and Caudofoveata. The second line includes Placophora represented by a single class Polyplacophora. It has all the salient features of the molluscan framework. The third line is that of Conchifera which includes three successful stocks of the phylum, namely the Gastropoda, Bivalvia and Cephalopoda. Of the other two classes, only Scaphopoda shows some signs of advancement while Monoplacophora is considered to be nearer to the origin of this line.

Following Seed (1983), the classification of phylum Mollusca is given below :

Phylum MOLLUSCA Cuvier, 1795

Subphylum ACULIFERA Hatschek, 1891

Class 1. APLACOPHORA von Jhering, 1876

Subphylum PLACOPHORA von Jhering, 1876

Class 2. POLYPLACOPHORA de Blainville, 1816

Subphylum CONCHIFERA Gegenbaur, 1878

Class 3. MONOPLACOPHORA Wenz, 1940

Class 4. GASTROPODA Cuvier, 1795

Class 5. BIVALVIA Linnaeus, 1758

Class 6. SCAPHOPODA Bronn, 1862

Class 7. CEPHALOPODA Cuvier, 1795

The relationship of classes within the phylum Mollusca is a subject of divergent opinions. Based on the embryology and evolution of shell the Cephalopoda were considered by some to have evolved independently from Coelenterata. Bivalves, scaphopods and gastropods have retained tetracyclomeric symmetry as in cephalopods. But it does not seem possible to derive bivalves from gastropods or vice versa (Lemche, 1961).

Scaphopods and bivalves have some similarity in their shells and also in not possessing a distinct head (Seed, 1983). In the early gastropods there was a planospiral shell, which was also found in primitive cephalopods. Both the groups have a distinct and well-developed head. From the parasitological point of view or rather from a 'flukes' eye view, Wright (1971) suggests close relationship among Gastropoda, Scaphopoda and Bivalvia and separates Cephalopoda from these.

According to Harry (1969) a prochiton stock gave rise to the Polyplacophora, which in true were ancestors to the Aplacophora. All other molluscs arose through a separate line, the Proconchifera. Monoplacophora is the earliest derivative of this branch. Proconchifera further gave rise to a group called Mesoconchifera, which in its turn gave rise to Probivalvia and Metaconchifera. The former gave rise to Bivalvia and Scaphopoda, and from the latter arose separately Gastropoda and Cephalopoda. The last mentioned two classes only have median dorsal mantle cavity. It is believed that the character has been derived from a remote promollusc.

1.2 General Organisation and Function

A mollusc has a soft unsegmented body with a slender slippery skin protected usually by a calcareous shell of different shapes and colours. The molluscan body is divisible into head, foot, and a dorsal hump-like visceral region covered by a shield-like mantle. The head and foot

are so combined that together it is known as head-foot region. Majority of the species can be identified on the basis of shell characters. But this typical shell may be absent in many forms. The shell which usually is external may be univalve (gastropods and scaphopods) or with two valves (bivalves) or eight valves or plates (chitons). In some gastropods and cephalopods excepting Nautiloidea, the shell is internal. General form and functions of the molluscan body are given below.

1.2.1 Molluscan Skin and Subdermal Tissues : The skin is composed of epithelium, which harbours ciliated columnar cells and goblet cells. The distribution and shape of the epithelial cells vary depending on the region of the body.

Dermal secretions, which consist of mucus, are important physiological phenomena of the mollusc. The nature of these secretions that are secreted by the goblet cells is dependent on the part of the body from where these originate. The secretions of body surface and mantle contain fluorescent substances, which are absent in the foot-sole mucus of pulmonates. The mucus secreting cells whose secretions act as repellents and protect the mollusc are abundant in the foot-sole region of gastropods. The periphery of foot and mantle contain glandular cells whose secretions act as repellants and protect the mollusc predators or pathogens such as miracidia, especially in the freshwater.

1.2.2 Mantle and Shell : These are the two important structures that distinguish Mollusca from all other phyla. The major function of mantle is to secrete a protective shell. The mantle encloses a cavity, known as mantle cavity, which is primarily a respiratory chamber. Within the mantle cavity are situated the ctenidium, osphradium, and the hypobranchial or mucus gland. Excreta from the anus or renal opening are discharged into it. It also houses the female genital organ. The mantle cavity thus serves for respiration, excretion, defecation and reproduction.

In terrestrial molluscs (pulmonates and some prosobranchs) the gills are absent and the mantle cavity with a rich supply of blood vessels serves as a lung. The mantle cavity is lined with ciliated epidermal cells that create currents by their movements. These ciliary currents assist in the oxygenation of water reaching ctenidia and in the removal of waste products. In sedentary gastropods and bivalves, collection of food is done through ciliary filter feeding mechanism.

The mantle edge bears three folds, namely the outer, middle and inner. The outer fold is involved in the secretion of the shell. The inner surface of the outer fold secretes the periostracum, whereas its outer surface secretes the outer calcareous layer. The inner calcareous layer is secreted by the entire mantle surface.

The shell is an important character of a mollusk and useful in the identification of species. It is thick or thin, heavy or light, opaque or translucent, usually colourful and ornamented with different types of sculpture. The sculpture may consist of spines, scales, varices, ridges, ribs, grooves, pits or threads.

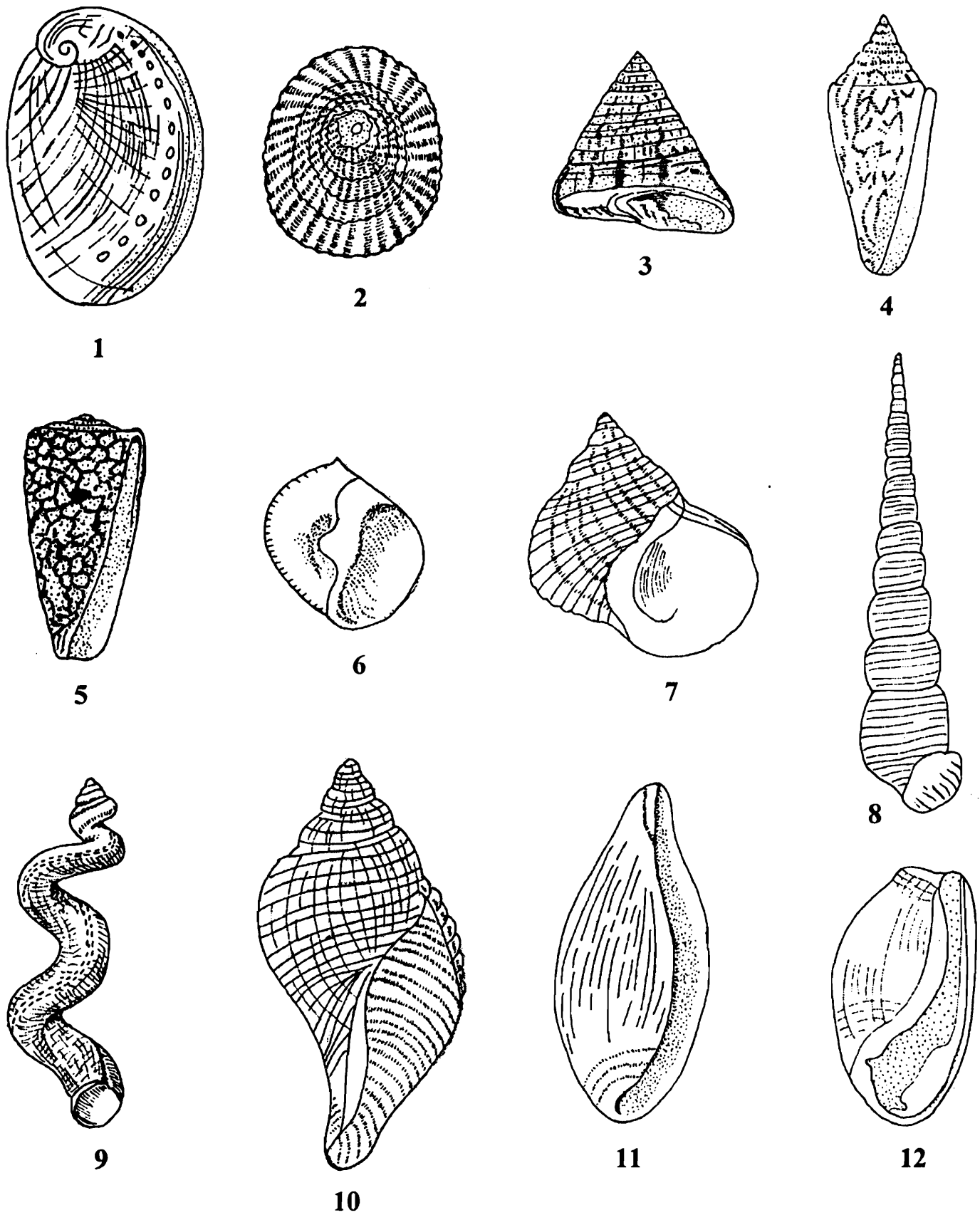


Fig. 2. Some shell shapes in gastropods.

1. Haliotid shape; 2. Patelliform or limpet like; 3. Trochiform; 4. Conic-biconical; 5. Conic-obconic; 6. Sphaerical; 7. Turbiniform; 8. Turreted; 9. Solute-uncoiled shell; 10. Fusiform; 11. Cypracoid and 12. Bulloid.

The shell has many conceivable shapes, spherical, cone, limpet-like, turreiform, turbiniform bulloid etc (Fig. 2). A shell may have successive turns, which are called whorls. The largest or the last formed is the body whorl. All other whorls together constitute the spire. The top of the spire is the apex and consists of a few nuclear whorls. The number of whorls may vary from a few as in neretids to many as in *Terebra* and may decrease gradually or abruptly. Periphery of the whorl may be rounded, angular or keeled. The line where one whorl meets with the other is the suture, which may be indistinct, shallow or deep.

In many molluscs the shell possesses a covering known as periostracum, which often peels off when dried exposing the colour pattern of the shell. In some molluscs such as olives, cowries, naticids the shell does not have a periostracum and when alive the shell is covered by the mantle folds.

Two types of spiral coiling are seen in gastropod molluscs. When a shell is held in hand with the apex pointing above the aperture facing the observer will be on the right hand side in a dextral form, and it will be on the left in a sinistral form. The latter are of rare occurrence in Indian gastropods.

The opening at the anterior end of the body whorl is the aperture. It has an inner lip and an outer lip farthest from the imaginary axis of the shell. Sometimes the columella bears a deposit known as columellar callus. The central axis of the shell opens through a small depression, or opening near the columella. It is known as the umbilicus and shell with an umbilicus is described as perforate and without it is imperforate. In some, the aperture may have a small canal at the posterior end and a broad canal at the anterior end. The former is known as posterior or anal canal and the latter anterior siphonal or siphonal canal.

Gastropods are broadly classified as operculates and non-operculates based on the presence or absence of operculum respectively. In the majority of prosobranchs operculum is present, attached to the foot. The operculum may be corneous or calcareous. On the inner surface in some, it has peg-like projection known as apophysis for firmly inserting into the muscle. The outer surface has a few increasing whorls and varies from smooth to granular. It is useful as an additional character in the taxonomic identification of certain families, genera and species (fig.3). Based on the nature of whorls it is described as paucispiral or multispiral.

The molluscan shell consists of three layers, namely an outer most organic and uncalcified structure known as periostracum, a middle calcareous layer and the innermost nacreous or mother-of-pearl layer. The periostracum is composed of a number of layers, which are more in freshwater gastropods than in the marine species. The second layer is the main structure of the shell and it is usually composed of calcium carbonate crystals. The innermost nacreous layer, found in several families of molluscs, is unique to this group. The calcareous layer may consist of entirely aragonite or calcite crystals. These crystals are like bricks, which are united by the conchiolin

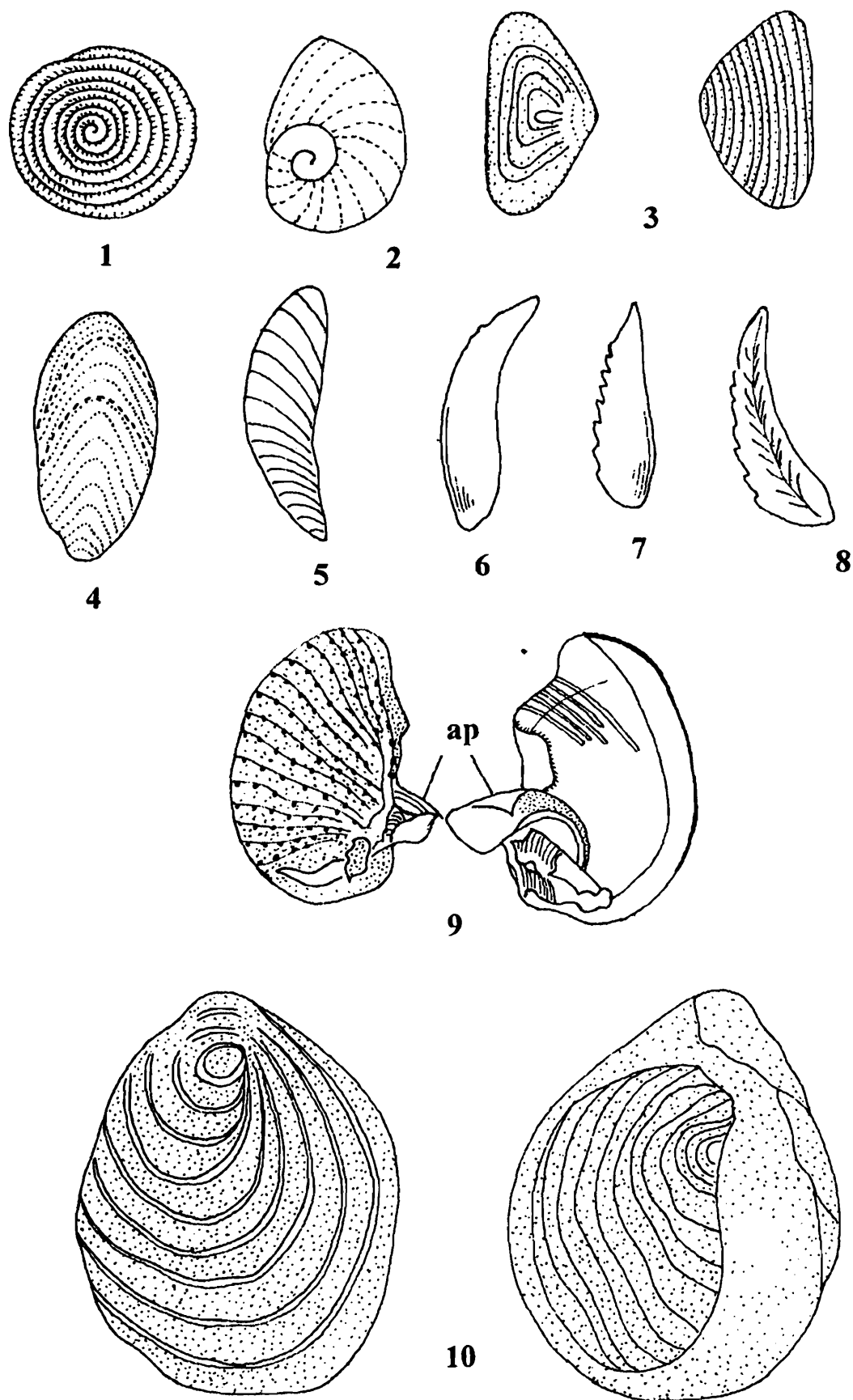


Fig. 3. Types of opercula.

1. Multispiral with a central nucleus; 2. Paucispiral with subcentral nucleus; 3. Coralliophila with marginal nucleus; 4. with apical nucleus; 5. Geniculate type: Fasciolaria 6. Strombus lentiginosus; 7. Strombus gibberulus; 8. Strombus listeri; 9. Nerita—outer and inner views. ap : apophysis and 10. Chicoreus, muricid—outer and inner views.

matrices, which correspond to concrete. The organic components of nacreous conchiolin consist of a linear network of extremely thin inter-lamellar sheets held together by transverse bridges. The nacreous conchiolin matrices vary in their structures in different groups. These structural patterns were statistically characteristic at the level of class.

Hitherto molluscan shell is considered to consist of three layers as mentioned above, but recently a calcareous layer (mosaicostracum) was discovered between the periostracum and outer calcareous layer. Ultra structure of the mosaicostracum is a potential tool for specific identification and for the study of evolution.

1.2.3 Digestive system : The digestive system converts food into a physical and chemical state suitable for proper absorption and utilisation by the numerous cells of the body. It includes the mouth, buccal cavity, oesophagus, stomach, digestive gland and intestine. Externally the mouth is surrounded by horny 'lips' and 'jaw' in gastropods, a pair of fleshy palps in bivalves, and hard mandibles in cephalopods.

The buccal cavity contains two important structures, odontophore and radula. The latter is a ribbon-like structure bearing a number of teeth. It scrapes the food from the substratum or cuts down solid objects into finer particles to facilitate their easy handling by the system. The radula is moved by the muscles of the buccal mass, which are supplied with haemoglobin. It is present in all molluscs except in Bivalvia. Typically, a radula consists of several transverse rows of teeth arranged in a longitudinal series. Each row consists of a central tooth also called rachidian, flanked on either side by laterals, and marginals. In the primitive gastropods there are numerous marginals. Primitive gastropods have rhipidoglossate radula with one central tooth, five laterals and numerous marginals. In majority of prosobranchs the radula is taenioglossate with one central, one lateral and two, three or no marginals. Highly specialized neogastropods possess a stenoglossate radula with one central and one lateral on either side. The number, shape, size and position of the teeth and cusps on different teeth are important characters for identification of genera and species. Depending on the food habit of the snail the radular teeth are modified. The following are different types of radula (Fig. 4) found in gastropods :

Rhipidoglossate (L-5-1-5-L). one central or rachidian, five laterals and numerous marginals on either side. Found in most of the archaegastropod families, like Haliotidae, Neritidae (L-4-1-4-L), Trochidae, Turbinidae etc.

Docoglossate (3-1-4-1-3) or (2-0-1-0-2) Multiple central, one lateral and three marginals. Patellidae, Lepetidae (2-0-1-0-2), Acmaeidae (2-1-0-1-2).

Taenioglossate (2-1-1-1-2). One Central, with one lateral and two marginals on either side. Almost all the Mesogastropod families, Littorinidae, Potamididae, Cypraeidae, Tonnidae, Ficidae, Cymatiidae, Bursidae etc.

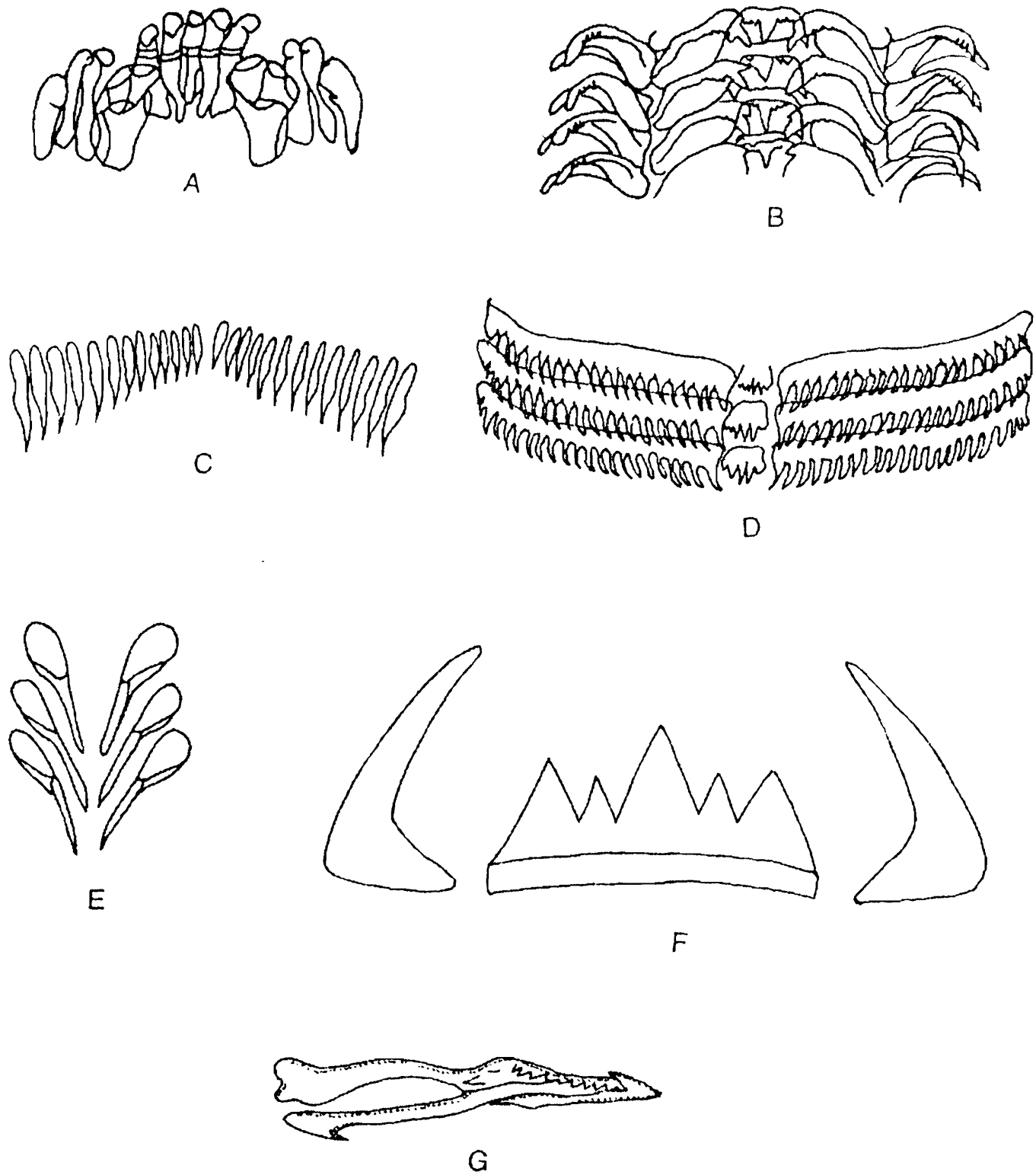


Fig. 4. Different types of Radula.

A. Docoglossate, B. Taenioglossate, C. Ptenoglossate, D. Rachiglossate, E. Toxoglossate, F. Toxoglossate-Muricid, G. Toxoglossate-Conidae.

Modified taenioglossate with the formula 0-2-1-2-0 occurs in Architectonicidae.

Ptenoglossate: No central, lateral and marginals not distinguishable. Epitoniidae, Janthinidae.

Stenoglossate: (1-1-1). One central and a lateral on either side. Majority of the Neogastropod families Muricidae, Buccinidae, Melongenidae, Olividae, Harpidae etc. In Columbelloidea, Central teeth may be absent (1-0-1), in Marginellidae and Cancellariidae only central present (0-1-0)

Rachiglossate has the same formula as stenoglossate (1-1-1) but the lateral elongate bearing numerous denticles.

Toxoglossate (1-0-1). Central absent or sometimes present, marginal teeth modified and harpoonlike. Conidae, Turridae and Terebridae

There is a pair of salivary glands opening into the dorsal surface of the buccal cavity. The secretions from the salivary glands serve as lubricants for the radula in its movement. The mucus secretions from these glands contain proteolytic enzymes and amylases. The mucus entangles the food particles, which form into strings. These strings of food pass from the buccal cavity into a tubular oesophagus, from where they move into the stomach.

The stomach is an important and complex organ in the digestive system of a mollusc. It is the site of extracellular digestion and into this open the digestive gland and intestine. The stomach consists of a style sac, which secretes a rod-like structure known as style. This crystalline style is present in some gastropods and bivalves. The style rubs against the thickened gastric shield of the stomach and breaks down in bits releasing various enzymes into the stomach. These include amylases, some times glycogenases and oxidases. In many herbivorous gastropods, especially basommatophoran snails, the anterior part of the stomach is modified as crop or gizzard and contains sand grains to assist in the grinding of food particles.

The digestive gland forms a major part of the animal. It receives food particles from the stomach. The digestion in the gland may be either intra or extracellular or a combination of both. Extracellular digestion is highly developed in the carnivorous prosobranchs. Undigested food passes from the digestive gland back into the stomach and thence into the intestine. In molluscs the intestine has no major absorptive function. It helps in rolling the faecal matter into pellets or chains.

1.2.4 Circulatory System : The vascular system may be open as in majority of molluscs or closed as in cephalopods. The closed system has capillaries connecting the arterial and venous systems, whereas open system has sinuses to transport blood.

Primitive gastropods have retained two auricles and the circulatory plan of the ancestral mollusc. In all other gastropods the right auricle is either vestigial or totally absent. Bivalves have two auricles enclosing a median ventricle. Gastropods also possess an auricle and a single ventricle. After vertebrates, Cephalopoda is the only class to possess a fully enclosed high-pressure blood system, consisting of well-established arterial and venous systems. The blood is

carried to all parts of the body by a single aorta, arising from the ventricle, dividing into an anterior and posterior artery. In many gastropods and bivalves there are two aortae namely posterior and anterior, the former supplying the visceral mass and the latter head and foot.

1.2.5 Reproductive System and Breeding : The sexes are separate in all the three minor classes, also in Scaphopoda, Cephalopoda, in majority of the bivalves, and in higher prosobranch gastropods. Only in certain gastropods and bivalves one species may be dioecious while its related species may be hermaphroditic. Archaeogastropods, among prosobranchs and opisthobranchs are protandric hermaphrodites, while pulmonates are simultaneous hermaphrodites. A few freshwater prosobranchs, i.e. thiarids are parthenogenic.

In many hermaphroditic species, mainly in the opisthobranch and pulmonate gastropods and in the bivalves, the change of sex is a general rule. Hermaphroditism is supposed to have arisen due to influence of ecological factors, and species that encounter difficulties for their reproductive activity, such as land molluscs, have developed hermaphroditism. In hermaphrodites the male and female gametes are produced either in separate follicles or from different areas of the same follicle. There is a common hermaphroditic duct, which divides into a separate sperm duct, and an oviduct for discharging out the male and female gametes respectively.

In the primitive archaeogastropods the gametes pass from the gonad through the genital duct into the right nephridium and finally into the mantle cavity. The genital duct consists of two parts, the gonoduct proper and the right nephridium. The fertilization is external and there is no need for copulatory organ. In all the other gastropods the right nephridium has degenerated leaving only the part that function as a gonoduct. It consists of the nephridial part of the gonoduct, the gonoduct proper and the pallial duct. The pallial part of the gonoduct is modified to store sperm and to secrete the egg membrane. A copulatory organ had developed to transfer the sperm into the female. The pulmonates and opisthobranchs have complex reproductive systems, which exhibit a number of variations. In these two subclasses details of reproductive system, including the structure of penis, are important in the systematics.

Many of the molluscs lay eggs and some like cowries even tend them after laying. Eggs hatch and release free-swimming larvae that can survive for long periods and swim long distances. Two types of larvae are seen in gastropod development, namely trochophore in primitive gastropods and veliger in others. A free-swimming larva is absent in some marine prosobranchs, such as neogastropods and in almost all pulmonates, where a tiny snail emerges out of the egg at the time of hatching.

1.3. Abundance and Distribution

Estimates of the number of molluscan species vary between 80,000 and 1,00,000. This figure is purely provisional as taxonomy of many families of molluscs is still in a confused state. It is well known that there are 'lumpers' and 'splitters' among taxonomists and depending on their

approach the numbers of species may decrease or increase as the case may be. Some times revisionary studies of families may also bring down the number of species in the changed species concept. For example in a recent revision of a freshwater family Lymnaeidae by Hubendick the number of species have been reduced from 1000 to 40.

Estimates of species vary from 35,000 (Boss, 1982) to 100,000 (Goetting, 1974) in gastropods, 15,000 (or 20,000) of bivalves, 600 cephalopods, 300 scaphopods and 635 species of other classes (Polyplacophora 500, Aplacophora 130 and Monoplacophora 5). Although molluscs occur in all possible habitats excepting aerial, these are abundant in the marine environment, which account for more than half of the known species. Of the seven recognised classes five, namely Aplacophora, Polyplacophora, Monoplacophora, Scaphopoda and Cephalopoda are exclusively marine. The two large classes viz. Gastropoda and Bivalvia are the most successful in adapting to different marine and freshwater habitats and include 94 per cent of the species of molluscs. The former has successfully colonised terrestrial habitats, whereas the latter could not overcome their filter feeding habit and hence had not been able to invade land.

Molluscs constitute an important component of marine biodiversity of India on the East and West Coasts and the islands of Lakshadweep and Andaman and Nicobar. Some important localities from where sampling was made are shown in Fig. 5. Five major classes, namely Polyplacophora, Gastropoda, Scaphopoda, Bivalvia and Cephalopoda are represented in India. Against a total of about 586 families in the world, an estimated 279 families occur in the Indian region (Subba Rao, 1998). These include 5042 species in all of which 3271 are marine, 1487 are land and 284 are freshwater. The estimates of land and freshwater species are based on the actual data, since these have been systematically well worked out. But the same cannot be said about the marine molluscs of which our knowledge is far from satisfactory.

Molluscs are found in various habitats (Fig. 6) from the deep sea (3600 m) off Andaman and Nicobar Islands to higher elevations (about 5000 m) in the Himalaya Mountains. But these are found in abundance in the rocky intertidal zone along mainland coast and in the coral reef ecosystem of Gulf of Mannar, Gulf of Kachchh, Andaman and Nicobar Islands and Lakshadweep. In comparison, sandy coasts support less molluscan fauna that include mostly burrowing and interstitial forms.

Marine molluscs are numerically abundant as individuals and as species. Majority of the known species are from the littoral region and search in the offshore and deep waters may reward one with new records and new species.

1.4. Size and Diversity

World size records of shelled molluscs are available in Wagner and Abbott's Standard Catalog of Shells. As far as the Indian molluscs are concerned no authentic records are maintained on the smallest or largest shell of India. However, based on the National Zoological Collections in the Zoological Survey of India an idea of size range among Indian fauna is given. Excluding the

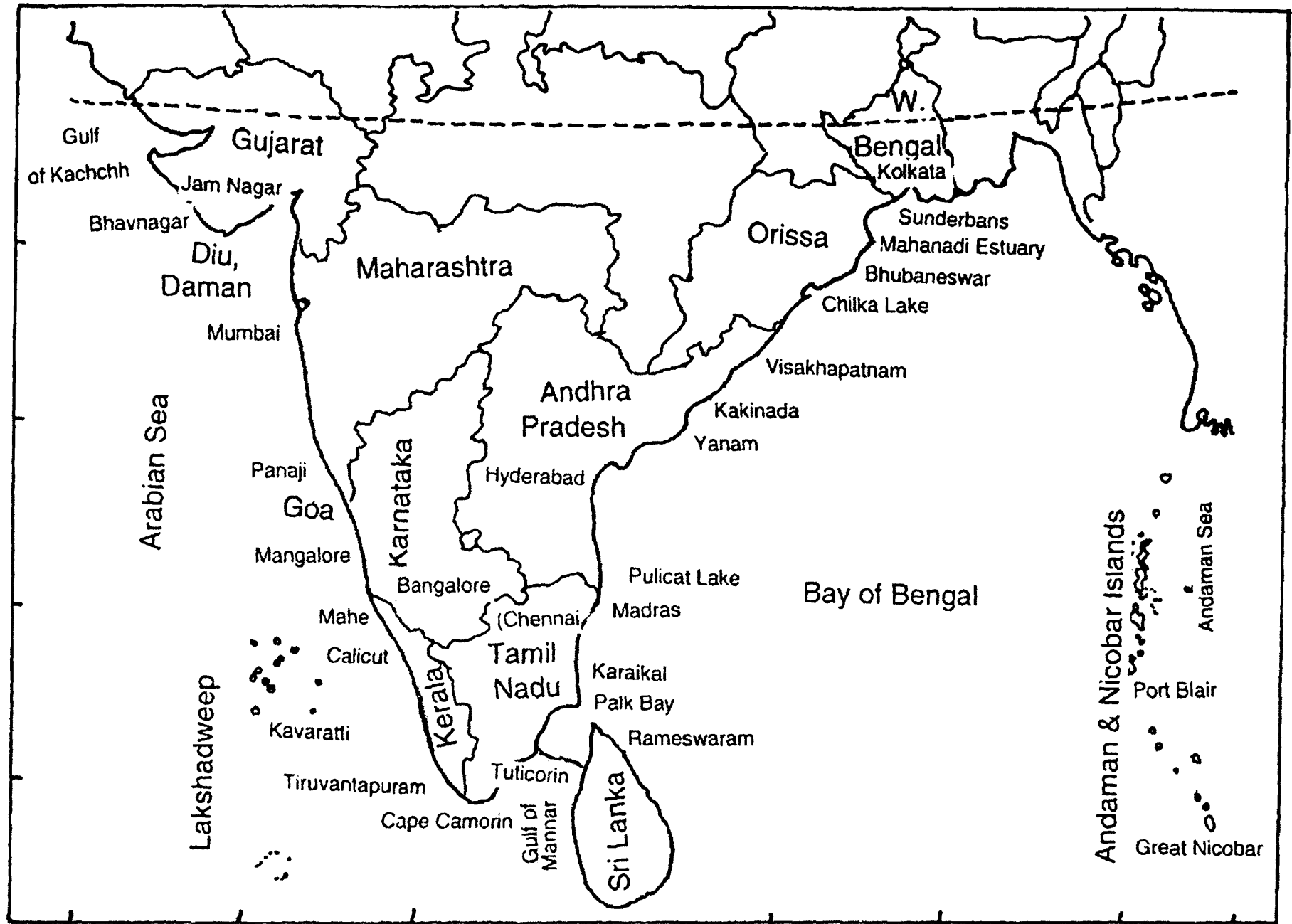


Fig. 5. Map of India showing important coastal localities.

1. Coral Reefs

Predators, herbivores, infauna; bioeroders, epifauna. Commercially exploitable resources. High species diversity. Coralliophilidae, *Drupella*, *Lithophaga*, *Cypraea*, *Conus*, *Drupa*, *Barbatia*, *Septifer*, *Spondylus*, *Trapezium*, *Tridacna* etc

2. Mangroves

Predators, herbivores, infauna; bioeroders, epifauna. Commercially exploitable resources. Species diversity moderate and populations abundant. *Littorina*, *Littoraria*, *Cerithiidae*, *Putamididae*, *Crassostrea*, *Teredo*, *Bankia* etc.

3. Seagrass Beds

On plants, on substratum or attached to coral boulders. Only a few species; about 15 to 20 gastropods and bivalves. *Cypraea*, *Conus*, *Cerithium*, *Tellinidae*, *Veneridae*, *Lucinidae* etc

4. Tidal Flats and Muddy Shores

Burrowers and epifauna on substratum. Only a few species; mainly bivalves, Gastropods represented by carnivores, *Nassarius*, *Pugilina* etc.

5. Sandy Shores

Infauna, intertidal : A few species. Meiofauna represented by 5 species. Macrofauna mostly bivalves with abundant populations : *Donax*, *Tellina* etc., Gastropods : *Oliva*, *Bullia*, *Babylonia*, *Terebra* etc.

6. Rocky Shores

Cryptic, epifauna, mostly herbivore gastropods : *Littorina*, *Littoraria*, *Cellana*, *Diodora*, *Purpura* etc., chitons and a few byssate bivalves. Infauna consists of two species of bivalves.

Fig. 6. Coastal Ecosystems and Habitats of Molluscs.

meiofauna, smallest specimens are from the marine genus *Cyclostrema* and the freshwater genus *Gyraulus*, which measure 0.75 mm and 4.0 mm respectively. *Charonia tritonis*, measuring 35 cm and collected from Nicobars is the largest Indian gastropod. The world size record for the same species, collected from Pacific, is 48.26 cm. Among bivalves the smallest size specimens are found in the freshwater genus *Pisidium* in which *P. annandalei* measures 3 mm. The largest bivalve in the National Zoological Collection is *Tridacna maxima* measuring about 37 cm occurring in the littoral zone of Andaman and Nicobar Islands. Specimens of *T. maxima* measuring around 100 cm occur in the Kamorta Island (where these shells are used as containers by the nicobarese for feeding their pigs). The largest clamshell, *Tridacna gigas* measuring 136.87 cm and weighing 230 kg was collected off Sumatra. Architeuthis (Gk. Chief squid), the giant squid is believed to be world's largest invertebrate and grows to a length of 21 to 24 m. It has very large eyes of the size of a dinner plate. Recently the New Zealanders caught two females (7 m and 4 m long) and a male (6 m long) at a depth of about 1000m in the Chatham Rise in the South Pacific Ocean.

Not only in size but also in shell shape, sculpture and colouration molluscs exhibit significant diversity. It is more pronounced in marine molluscs, which display flamboyance in colour and in form within and between species. In comparison, freshwater and land mollusks are less colourful.

Diversity is also evident in mollusc feeding habits. There are herbivores, carnivores, scavengers and deposit feeders, suspension feeders, commensals and parasites. The only carnivorous land snail of India, *Gulella (Huttonella) bicolor* has been reported to feed on garden snail. All the freshwater forms are either herbivores or suspension feeders. It is the marine molluscs, which occupy diverse habitats and exhibit diverse feeding habits.

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2. VALUES OF MOLLUSCAN DIVERSITY

The association of molluscs and man has been very old, dating back to prehistoric times. Heaps of discarded shells were found in the kitchen middens and in the excavations of stone-age cultures. There are evidences to show that shell trade existed in protohistoric Iran and Southern Asia (Durante, 1979). Shells have fascinated man from the time he came in contact with molluscs. The shells were strange and rare objects for the primitive man. Attracted by the beauty of the shells the primitive man picked them up on the sea beach and the wandering tribes carried them inland. The people of inland who never saw a sea, could not even imagine such objects and hence viewed them with respect and curiosity. These natural objects were taken as mysterious and marvelous creations of nature. As the association grew man attributed magical and mythical powers to shells and had also started manufacturing various articles out of them.

The primitive man came in contact with the mollusc through its shell, which is an important character of the group. Shell and mantle or skin are the two important characters, which are responsible for the development of a close bond between molluscs and man. Mantle is a unique structure to molluscs and one of its main function is the secretion of shell, a protective covering to the soft animal. Each shell stands as a monument to the miraculous and mysterious system of creation. These shells have become invaluable resource materials, based on which man has developed industries with promising returns.

The importance of the molluscs to man can be broadly treated under the following heads:

1. Aesthetic value
2. Commercial value
 - A. Raw material for shellcrafts
 - B. Source of calcium and lime
 - C. Pearls
3. Gastronomic value
4. Biomedical value
5. Marine biodeterioration.

2.1. Aesthetic Value

Aesthetic appeal of a shell is due to its colourful exterior and the perfection of its shape, which in the majority consists of a spiral curve. Although there are seven classes of molluscs only two, namely Gastropoda and Bivalvia and Nautilus in Cephalopoda have developed such external shells, which appeal to human eye. Of these, gastropod shells have attracted man from the beginning.

A snail's shell is cited as an example of mathematical perfection and what is mathematically perfect is also considered as an object of perfect beauty. Beauty evokes an immediate sensuous pleasure, which is a common human experience. The shell form is not only beautiful and regular, but has also proved to be efficient and useful to its possessor. The growth of shells is an example of generating spiral curve. The shell grows with a constant increase in its size, but without any change in its geometric proportions.

Mathematically speaking there are several forms of spirals of curves. But as far as molluscs are concerned there are two important spirals, namely the equable spiral or spiral of Archimedes and the equiangular spiral or logarithmic spiral. The former is not as common in nature as that of equiangular. When a rope of uniform thickness is coiled tightly on a horizontal surface the spiral of Archimedes is formed. In this type of spiral each whorl is of the same breadth as the one preceding and the one following it and the radius of the coil increases in arithmetical progression. This type of spiral is seen in the opercula of *Trochus* and a few other shells.

In the logarithmic type of coil the whorls continuously increase in breadth at a steady and unchanging ratio. In 1638, the French philosopher Descartes called it the equiangular spiral, and in 1691, Jacques Bernoulli called it the logarithmic spiral, while others preferred to call it the geometrical spiral. The fundamental mathematical property of the equiangular spiral corresponds precisely to the biological principles that govern the growth of the molluscan shell.

2.1.1. Geometrical Symmetry-Nautilus : Geometrically perfect and aesthetically appealing is the shell of Nautilus, which gets washed ashore on the coasts of Andaman and Nicobar Islands. There are as many as 38 chambers in a full-grown Nautilus. The first four chambers are formed when the young Nautilus is still within the egg and new chambers are added at the rate of one every 2 or 3 weeks. The successive chambers of Nautilus are built on a framework of logarithmic or equiangular spiral. As the shell grows to accommodate the growing animal, the size of chambers correspondingly increases, but the shape remains unchanged. The increase in length is balanced by a proportional increase of radius so that its form remains unchanged.

The shell of Nautilus with its colourful exterior of reddish-brown flame markings on a creamy white background is an object of aesthetic value and of commercial importance. About one-lakh shells of nautilus are collected and exported annually from the Philippines. A polished shell reveals its lustrous mother-of-pearl layer, which is cut and engraved into table lamps, and other ornamental items like spoons, ear-rings, studs, spoons, cups and saucers.

Thus we can cite a number of shells, which have fascinated man with their marvelous and geometrical symmetry. The spiral coiling can take on many shapes. In abalone or ear shell (*Haliotis*) the generating curve grows very rapidly and the last whorl becomes suddenly large

but maintaining the spiral curve. In the sundial shell (*Architectonica*) the whorls may increase in breadth very slowly, almost to the point of simulating an Archimedes spiral.

2.1.2. Cones : Some of the shells have become important not simply because of their shape or beautiful colour, but because of their rarity in nature. Cones, considered as molluscan aristocrats, are one such group. From the beginning when the shell collection has developed into a hobby cones are much sought after by the collectors. Although there are about 400 species of cones, a few only are considered as pride possessions by any collector. There are a few cones, whose discoveries have created quite a sensation. The two rare cones that made history are 'Glory of the Sea', *Conus gloriamaris* Chemnitz, 1777, and 'Glory of India', *Conus milneedwardsi* Jousseaume, 1889.

The famous cone shell, 'Glory of the Sea' was believed to be the most rare shell until September 1969, when the aqualung divers discovered a number of live specimens off the north coast of Guadal canal, Solomon Islands. The first specimens of this cone appeared in an auction in 1757. No body knew who gave it the now well-known title and from where the specimen was collected.

The first authentic collections (two live specimens) of *C. gloriamaris* were made by Hugh Cuming, prince of shell collectors, on an island north of Mindanao in the Southern Philippines. Only a few specimens were known to collectors till middle of 20th century. The craze for this cone was so much that it has been made a central theme of a Victorian novel, titled *Glory of the Sea*, published in 1887 by Francesca M. Steele. The shell has created such an irresistible temptation that it has lead to the theft of a specimen in 1951 by breaking open an exhibition showcase in the Museum of Natural History. In 1957 one shell of *C. gloriamaris* was sold for \$ 2000. The popularity or value of this shell has been mainly due to its rarity, since the shell does not offer any excellent shape or colour. The shell, which bears some resemblance to textile cone (*C. textile*), is tapering with fawn to russet coloured tent markings on a creamy background.

The other rare shell, which is one of the most sought after shells of today, is the 'Glory of India' cone. In 1890, F.W. Townsend collected some specimens off the Bombay coast while laying Telegraph cables. Later in 1903, another specimen was collected from near Bombay and is deposited in the National Museum of Wales. Subsequent collections in 1930 and 1960 from Mauritius have brought the total specimens to about a dozen. But in the later part of 1960 more specimens were collected by deep trawling from a depth of 150 fathoms off Mozambique, East Africa and three of these specimens were sold in the United States for a sum of \$ 2400 (Saul, 1974).

While the above mentioned two cones are considered as pride possessions by shell collectors, there are other 27 species of cones which are important because of their poisonous nature. If picked up alive a poisonous cone is capable of shooting a tiny but deadly dart into the person's

hand. The dart carries a poison that is almost as virulent as that of a cobra. Although there are no records from the Indian seas of the poisonous cones, there are many records from the Great Barrier Reef. In India there are five species of venomous cones viz. *Conus geographus* (Geography Cone), *C. aulicus* (Princely Cone), *C. marmoreus* (Marble Cone), *C. tulipa* (Tulip Cone), and *C. textile* (Textile Cone) occurring in the reefs of Andaman and Nicobar Islands, Gulf of Mannar and Lakshadweep. The first mentioned is the most dangerous.

2.1.3. Cowries : Considered as jewels of the sea, cowries have a longer association with man than any other shells. Their utility to man has been in three basic ways, as aesthetic or ornamental objects; as charm, amulets or talisman; and money.

Two basic needs - food and procreation - dominated the life of primitive man. When he picked up a cowry on the shores of the Red Sea, he found a fanciful resemblance between the sexual parts of a woman, and the shape, colour and form of the aperture of a cowry. He believed that an object, which appeared similar to a part of human body, could magically influence the same part. Thus, he attributed vital and magical powers to the cowry (Saul, 1974). This led to the belief that the cowry has the power of conferring fertility and it became the symbol of womanhood. Woman in several parts of Europe and Japan used to wear cowry shells as pendants, girdles and bracelets in the belief that they conferred fertility and assisted in the process of parturition.

Cowries are imbued with talismanic or magical properties. They were often used as charms against the evil eye. Often rural folk in India tie cowries to the horns of bulls or camels. Some have suggested that the resemblance of the apertural side of the cowry to the half closed human eye is the basis for this belief.

Cowries were used as currency in many parts of the world. Of the 200 species of cowries known, only two were used commonly as currency: the Gold-ringed cowry, *Cypraea annulus* and the Money cowry, *Cypraea moneta*. Even till recently, these were used as currency in central New Guinea and Africa.

Cowries were used in the preparation of ornaments like purses and ladies' handbags. These were collected in large numbers from various places in the Indo-Pacific region, where they are abundant in the coral reefs. During the middle ages and in the years of the Dutch and English East India Companies cowries were fished near Maldives and Sri Lanka. From here they were shipped to the European Countries such as the Netherlands, England, Portugal and others in barrels or sacks. From the records it is known that Maldives alone exported 1000 million cowry shells in the year 1800. From various such export figures Dr. M. Schilder calculated that if all the cowries exported are joined in one chain, it would go 37 times around the earth at the equator and reach four times the distance from the earth to the moon (Cernohorsky, 1967). This explains how popular the cowries were.

According to recent Indian foreign trade statistics, 45 tons of cowries were exported in 1977, of which U.S.A. alone imported 12 tons. To meet the demands of Indian shell crafts industry a few species of cowries are imported to India; 17 tons from the Maldives and 22 tons from Tanzania were imported in 1976. Seven species of cowries are involved in this trade: tiger cowry, *Cypraea tigris*, *C. lynx*, *C. caputserpentis*, *C. chinensis*, *C. diluculum*, *C. erosa* and *C. vitellus*.

2.2. Commercial Value

Seashells are known for their beauty and there is a growing business in seashell export. The collections usually are classified into commercial shells and collector's shells or specimen shells. Shells that have an aesthetic appeal are collected or purchased by hobbyists or members of shell clubs, which are popular in U.S.A. and Europe. Such shells are preserved intact as natural history specimens. Commercial shells are ground, polished and cut into various sizes and used in shell craft industry.

Seashell exports from India have risen from 20 tons in 1969 to 466 tons in 1979 (Wells, 1981), when the main importing countries were U.S.A., Bahrain and Kuwait. There is increasing demand for seashells in U.S.A., Japan and Europe. The Philippines is the leading exporter of seashells with around 80 per cent followed by South Korea, Thailand, Taiwan and Mexico. India has a 5 per cent share in world market but expected to exceed 10 per cent in a few years.

Shells are collected off Tamil Nadu coast, Kerala, Andaman and Nicobar Islands and of late from Orissa. It was reported that one Shell Craft Industry in Bombay processes around 1200 tons of seashells annually. Of this about 200 tons are thrown away since the shells do not conform to certain standards of colour, shape and size.

2.2.1. Raw Material for Shellcraft : In addition to their exploitation to meet the demands of international shell trade, seashells are also needed in large quantities by the domestic shell craft industry. Seashells are used in the preparation of ornaments and household articles such as table lamps, ashtrays, *agarbatti* stands, door hangings etc. These are also used in the lime industry, poultry feed additives and the fine lime obtained from the shells is used in pottery glazes, toothpaste etc. Some of the shells are commercially important because of their nacre, commercially known as mother of pearl, which is used in decorative inlay work. The number of shells put to industrial use are more than those used in ornamental shell trade.

Puri is a major centre for collecting, processing and marketing of seashells. The Govt. of Orissa has a Seashell Handicrafts Training Centre, at Puri, which trains young boys and girls in the art of shell craft. The finished products from the artisans are purchased by the Orissa Handicrafts Corporation, and Khadi and Village Industries Commission, and sent to Calcutta, Bombay, Madras and Delhi to be exported to foreign countries. Shells are used in jewellery



Fig. 7. Value added products of *Trochus niloticus*.



Fig. 8. Display of jewellery out of Top shell.



Fig. 9. Nancowry shells from Gulf of Mannar.

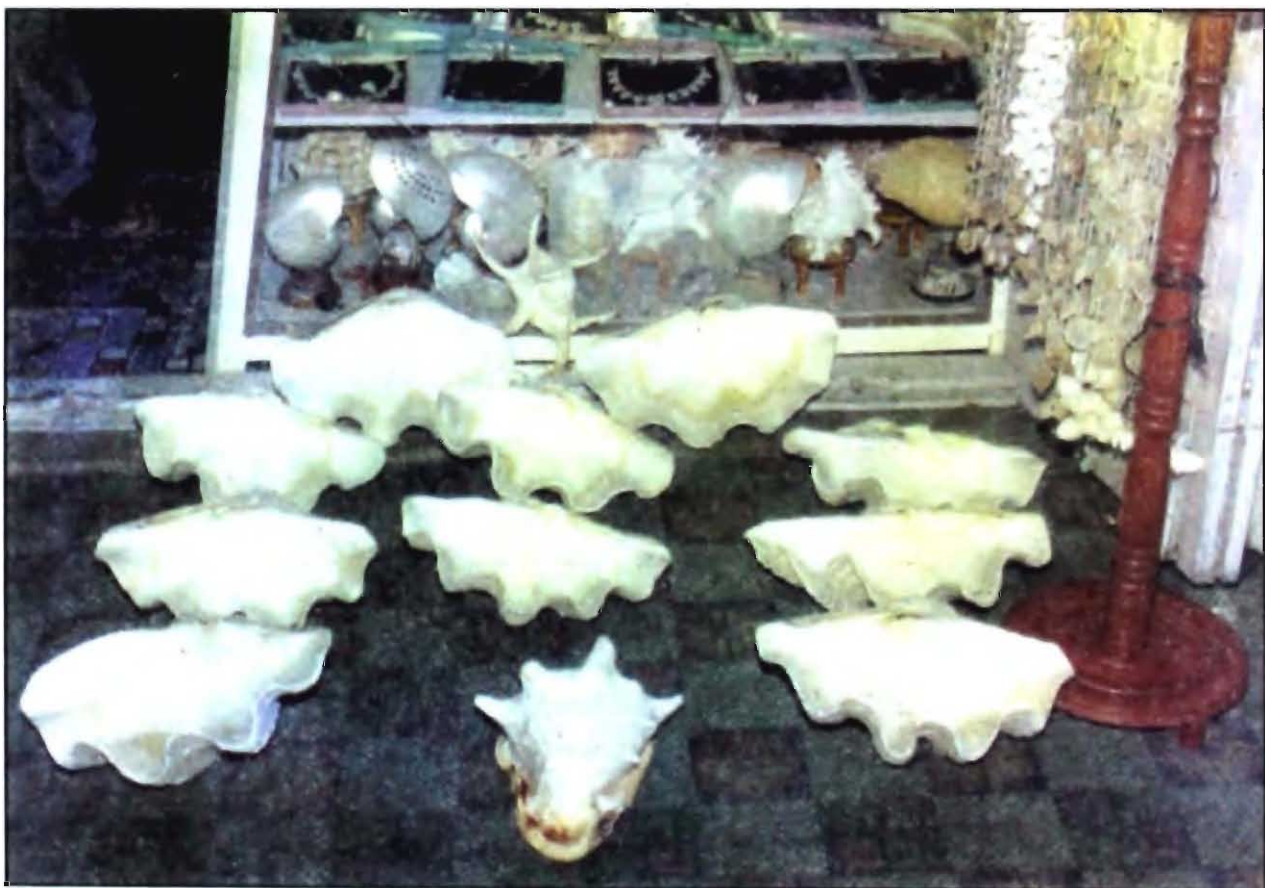


Fig. 10. Nautilus Table lamp, spider conch and Giant clams.



Fig. 11. Mango shell in the center, cones and Babylonia at the bottom.



Fig. 12. A mirror decorated with bivalves all around. Nearly 200 shells are used.



Fig. 13. Nautilus- Table lamp in the center flanked by shells in their natural colour.



Fig. 14. Turban shell (*Turbo marmoratus*) polished and natural shells.

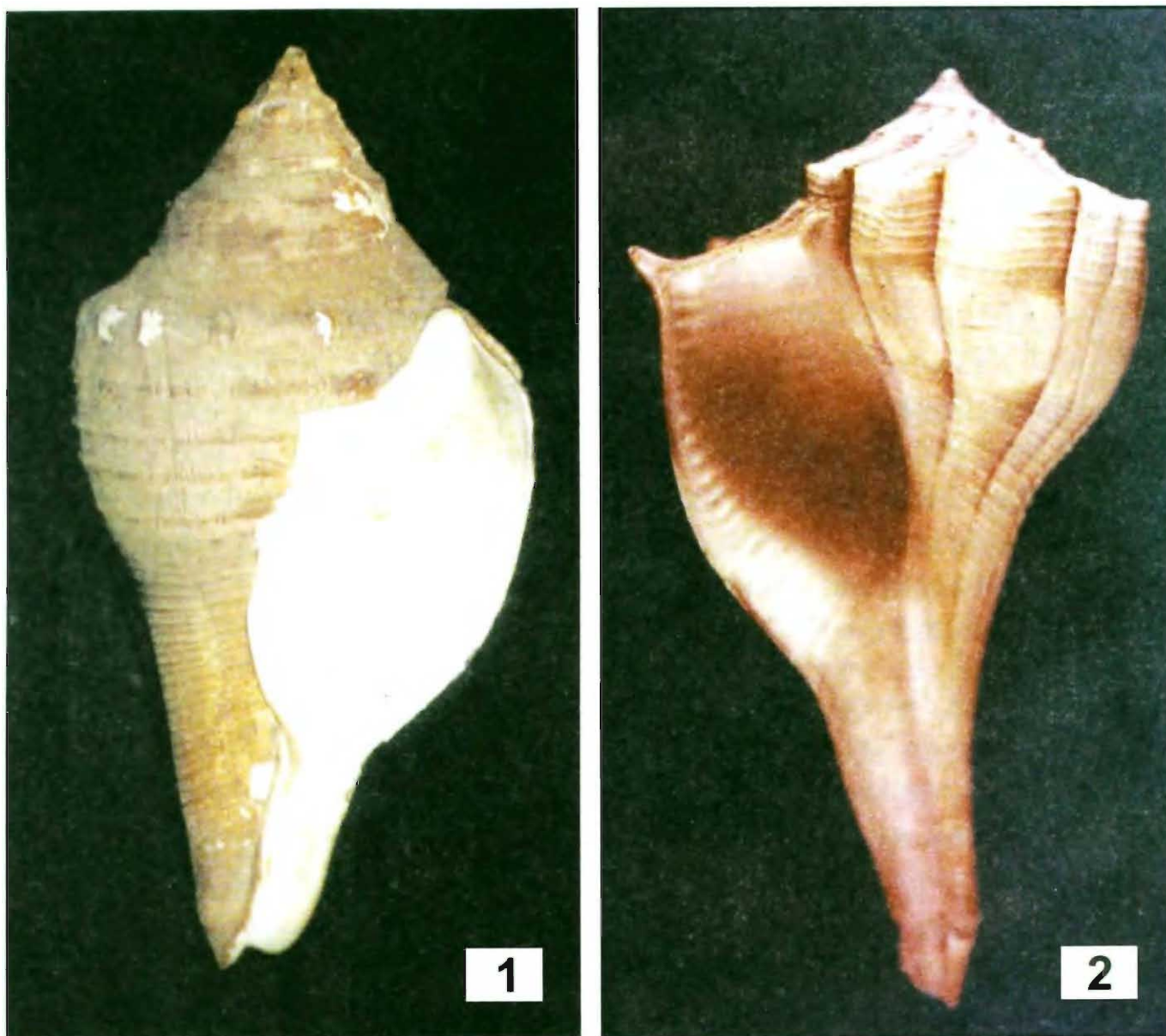


Fig. 15. 1. Indian Sacred chank *Turbinella pyrum fusus* and exotic sinistral shell.
2. *Busycon contrarium* sold as substitute for sinistral chank.

items, curios, wall hangings, door screens *etc.* Besides many marine bivalves, shells of *Pugilina*, *Murex*, and of King shell, *Achatina* and *Lamellidens* are also used by the artisans of Puri. Preparation of *Sankha bhasma* from a marine bivalve is used in Ayurvedic medicine. Golden cowry was a symbol of fertility and designs are made with it to ward off evil. Cowries arranged in a particular fashion are hung on a wall on the 6th day of newly born baby.

There are cottage industries in Ramanathapuram dist., Tamil Nadu, which manufacture beautiful curios and several utility articles with molluscan shells. Many families of fishermen are profitably engaged in the collection and trading of shells. A survey by Radhakrishnan

Nair *et al.* (1976) showed that there were nearly 25 small establishments dealing exclusively with shells and shell articles. We do not have proper statistics, but there are small shellcraft units in Kanya Kumari (Cape Comorin), Madras, Hyderabad, Puri, Digha, Calcutta, Port Blair and other places, which draw natural, raw shells from the Gulf of Mannar, Andaman and Nicobar Islands. The finished shell products from these units are sold in local market, and transported to inland cities of India and a few exported to U.S.A., Europe and Japan.

Garlands, chains, necklaces and other ornamental articles are made out of *Pyrene*, *Oliva*, *Umbonium*, *Planaxis*, *Nassa*, littorinids, cones, cowries, *Placenta placenta* (Windowpane Oyster) *etc.* Household articles such as table lamps are made out of shells of *Turbo marmoratus* (Green Snail), *Trochus niloticus* (Top Shell), *Nautilus*, *Chicoreus ramosus*, *Lambis lambis* (Spider Shell) and *Melo melo* (Beggar's Bowl) (Figs. 7–13).

Chanks, Turban Shells, and Top Shells are the most popular among shell traders because of their large size and glittering surfaces when polished. The most valuable commercial mother of pearl is obtained from *Turbo marmoratus*, *Trochus niloticus*, *Turbinella pyrum* and *Pinctada fucata*, the Indian pearl oyster.

2.2.1a. Chank : Sacred chank has established an inseparable relationship with humanity from times immemorial. Ornaments made out of chank were found in excavations of Mohenjadaro and Harappa. The importance of the chank in Hindu religion and life are portrayed in several legends. Chank shell was favoured as a trumpet in the olden days. The *Bhagavadgita* refers to different chanks namely *Pancha Janya* (by Sri Krishna), *Ananta Vijaya* (by Yudhishtira), *Paundra* (by Bhima), *Devadatta* (by Arjuna), *Sughosha* (by Nakula) and *Manipushpaka* (by Sahadeva), which were used as trumpets in the battlefield of Kurukshetra. Lord Vishnu is portrayed as one holding a sinistral chank, which was obtained from the 'Ocean of Milk' at the time of churning for divine nectar. Chanks have been associated with Buddhist deities also.

Chank blowing is a usual custom to announce any auspicious, religious or sacred event. In Bengal the custom of chank blowing during marriages is very common.

“ May Ganges water and sea-chank betide
Enduring bliss to bridegroom and bride”

is the hymn recited during marriage. Chank bangles are worn by married women.

In South India, chank is blown in all Hindu religious rituals including last rites. According to Tamil literature an important chank cutting industry had existed nearly 2000 years ago. But the industry in south had gradually declined. It was later revived in Bengal, where a well-flourished chank industry exists at present. According to recent reports, in West Bengal there are 5000 families dependent on conch shell industry. The industry has artisans spread over in the districts of Howrah, Bankura, Burdwan, 24 Parganas and Calcutta.

According to the *Sankha Silpi Sangha*, the market for conch shell products, especially bangles, has improved considerably over the years since women in Bihar and Orissa also started using these bangles as an alternative to the usual commercial ones.

In West Bengal alone there is a demand for 2.4 million conch shells but so far the annual average supply has been in the region of 1.9 million shells. Besides the domestic demand, chanks are also in demand mainly in Italy, Spain, France and the U.S.A. Chanks, which occur at a depth from 30 to 45 m in the Gulf of Mannar and at lesser depth in the Gulf of Kachchh are fished at intervals. The rights for fishing are leased out by the respective state Governments.

Chank is restricted in its distribution, because of the absence of a free-swimming veliger stage in its development and inability of adults to swim to new territories. Overexploitation automatically leads to decline in their stocks. A survey made in 1910 showed that there was a severe decline in the numbers of shells collected due to overfishing in the preceding years. During the first half of the previous century four to five million shells were said to have been collected annually from the Gulf of Mannar alone. The depletion has led to serious crisis in the domestic industry and also to reduction in the export trade; the export of chank shells has fallen from 55 tons in 1976 to 18 tons in 1977 (Wells, 1981). The chank shellcraft industry often faces serious problems because the Tamil Nadu Fisheries Department is either holding up or not able to supply the required quantity to West Bengal Handicrafts Corporation, the nodal agency, which receives the raw shells and distributes them to different artisans in the State. Since India is not able to supply the chank shells, Bangladesh is importing raw shells from Sri Lanka.

Recent data indicate that there is an increase in the landings of sacred chank in the Gulf of Mannar. There is a 34% of increase in the production from 1990-91 to 1991-92. The average catch per a diver increased from 1.3 chanks in 1990-91 to 22 chanks in 1991-92.(Anon, 1993). But the details of chanks fished (Peer Mohamed Pers. Comm.) do not indicate any substantial increase. During the year 1989-90 a total of 84496 nos. of good quality chanks and 73150 nos. of worm-eaten and undersized chanks were fished in the season (November to March), which included 98 diving days. In 1990-91 chank diving was held for 120 days yielding a total of 162675 chanks of which 99943 were of good quality. Next year (1991-92) during 27 days of diving 36448 chanks were collected of which 20881 were of good quality.

A sinistral chank is a rarity in nature and it is deeply venerated by devout Hindus. During recent years unscrupulous businessmen are out to exploit the sentiments of ignorant people. Left handed Lightning Whelk, *Busycon contrarium*, which is very common in Gulf of Mexico, West Florida, is imported to India and sold as a sacred chank thus playing to the religious sentiments of the people (Fig. 14). It is one of the very few naturally sinistral marine species that grows to 40 cm length, whereas the Indian sacred chank normally is a dextral species. Large specimens of *Busycon* are sold in pilgrim centres on the west and east coast of India and many have found their place into Calcutta and Port Blair markets also. Large specimens of this exotic species are now seen in many Hindu houses and temples along with the true sacred chank.

2.2.1b. Trochus and Turbo : *Trochus niloticus* and *Turbo marmoratus* are two commercially important gastropods. Both the species are distributed in the coral reefs of Andaman and Nicobar Islands and occur up to 20 m depth. *Trochus* is exploited since 1900 and the introduction of new techniques by the Japanese divers in 1929 has depleted the stocks rapidly. Continued commercial fishing of *T. niloticus* in Andamans has reduced quantities of shells fished from 500 tons to less than 40 tons in one season. In 1933, an hour-long search by a diver could yield 20 shells, which had fallen to two to three by 1935 (Rao, 1937). During the years 1939-45 commercial fishing was stopped and the beds were allowed to recover. Growth of *Trochus* is quite fast for the first 2-3 years (8 cm base diameter). A ten year old attains the size of 12 cm. Even a landing of 1000 tons has the risk of causing sharp drop in the next year. As per the recent estimates the annual production of *Trochus* ranges from 400 to 500 tons (at @ Rs. 65,000 per ton) and that of *Turbo* from 100 to 150 tons (at @ Rs. 90,000/- per ton). Both the species are overexploited in the Islandas. *Turbo* is commercially extinct and *Trochus* is collected in a few kilograms. Between 1994-95 and 1998-99 an average of 1825 kgs. of *Trochus* per year were collected, with the highest quantity of 4382 kg. in 1996-97 and the lowest of 450 kg. in 1995-96. During the same period *Turbo* averaged 80 kg. with maximum catch of 210 kg in 1994-95 and a minimum catch of 20 kg. in 1998-99.

In the international shell trade there is an annual demand of 6000 tons of raw *Trochus* shells (Bouchet and Bour, 1980). New Caledonia and New Guinea are the two important centres from where *Trochus* are fished in large quantities.

2.2.2. Source of Calcium and Lime : The molluscan shell forms one of the important raw material for many calcium/ calcium carbonate based industries, since 33 to 40 per cent of the shell is calcium, 90 to 98 per cent of which occurs as calcium carbonate. Tooth powder from edible oyster shells has been perfected at Render (Surat) laboratory of the Gujarat Fisheries Aquatic Science Research Institute. Shell grit also forms an important ingredient in the preparation of dental cream, talcum powder and in carbide industry.

An organised lime burning industry exists in a number of villages on the east and west coasts of India. Huge quantities of shells are collected along Kerala coast, Tamil Nadu, Andhra Pradesh and Orissa for use in the preparation of slaked lime and poultry feed. Shells play a prominent role in the economy of local fishermen at Kakinada, Andhra Pradesh and at Ashtamudi Lake, Kerala. According to Narasimham (1973) fishermen belonging to 15 villages exploit the molluscan fishery resources of the Kakinada Bay.

The molluscan fisheries of the Kakinada Bay include the following species :

- Bivalves :
1. *Placenta placenta* – Windowpane oyster, important and most valuable
 2. *Anadara granosa* – Granular ark shell
 3. *Meretrix meretrix* – Bay clam
 4. *Marcia opima* (*Katelysia opima*) – Inflated clam
 5. *Paphia malabarica* – False clam or short neck clam
 6. *Donax cuneatus* – Donax shell

- Gastropods :
7. *Umbonium vestiarius* – Button shell
 8. *Cerithidea cingulata* – Cerithid snail
 9. *Pugilina cochlidium* – Spiral melongena
 10. *Telescopium telescopium* – Telescope snail

Every year a few hundred tons of shells are collected by about 300 licensed fishing boats. An estimated catch of 6020 tons (fresh weight) valued at Rs. 1,95,000 was landed in 1968, the value of which would increase when converted into lime.

Shell lime is popular in Orissa and it comes mostly from the coastal villages in Baleshwar (Balasore) and Ganjam districts. In Berhampore town there are eight bhatties (lime-burning kilns) in Kamapally area. In lime manufacture bivalves are preferred over gastropods. In Berhampore, venerid bivalves are mostly used and *Cerithidea cingulata* is the only gastropod used in lime making. The cerithids are collected from the nearby Gopalpur creek and other back waters. As the local collectors are not able to meet the demand of lime manufacturers, shells are transported in trucks from Balacheruvu, near Visakhapatnam.

Shells are also collected from Pallur, Ganjam, Gopalpur, Golabanda, Markandi, Ramyapatna and Sonapur. There are subfossil shell deposits in the neighbourhood of Rambha and in Bahuda riverbed near Surla.

Forty-five tins (each of 15 litres) of shells and 45 to 50 tins of coal are used in one operation in a kiln. The shells are burnt for 3 ½ hours. About 75 kg of lime is obtained in one operation. The kilns are active for about 6 months in a year with a peak activity in October. In one season, that lasts from October to December the kilns are operated for about 20 times in a month, but during off season it is five or six times in a month.

At Surla, Sonapur and Pattisonapur there is an extensive bed of edible oysters covering a total area of about 162 ha, which is annually leased out by the Department of Fisheries, Government of Orissa.

The shell trade at the border of Orissa and West Bengal is mainly centred on one particular species, the Bay clam *Meretrix meretrix*.

The trade is distributed over the following points :

1. Collecting or shell-picking centre
 2. Stocking centre or transporting centre
 3. User agencies
1. Kirtania situated on Subarnarekha River is the main collecting centre of shells, where the collecting activity extends over most of the year, without any restrictions or closed seasons. But in general the collectors avoid picking young shells. The examination of huge stocks of shells piled at Talsari, a border village near Digha, had revealed that the smallest shell measured 13.7 x 8.3 mm while the larger ones were 29.5 x 23.2 mm.

2. Traders purchase shells from the collection centre and transport these in boats to Talsari from where the shells are supplied to various user agencies. Raw shells with flesh intact are priced at Rs. 4/- per quintal. These are loaded into boats, which carry about 60 quintals. From the information available there are about 30 to 35 boats engaged in this shell trade. At the time of our visit in 1998 we could count 14 heaps of shells stocked at Talsari. Taking the costs involved i.e. labour, transport and other incidentals the cost of one quintal of shells comes to around Rs. 15/-, by the time it is ready to be dispatched to user agencies, to which they add their own profit and sell at Rs. 20/- a quintal.
3. From Talasari shells are transported to various destinations in West Bengal such as Port Canning, Diamond Harbour and Midnapore. Every month about 20 truckloads, each truck carrying 12 tons, are distributed from Talasari. Although the supply of shells continued throughout the year, it was brisk during summer. Thus annually about 2500 tons of shells, mainly of bay clam are exploited.

As per the information given by the local people there are more than 1000 persons (of all ages) thriving on the shell trade from collection to transporting inland to user agencies. These shells are ground and utilised as poultry feed additives. *Paphia malabarica* is exported in large quantities from Kerala.

2.2.3. Pearls

What is a pearl ? : A pearl is more or less a round concretion of skeletal material. It implies that animals, which are capable of secreting some sort of skeleton, can also secrete pearls. Thus one may find rarely in nature chitin pearls in insects, horn pearls on horns of certain mammals. Pearls, which are popular as gems are secretions by molluscs. All those mollusks, which possess shell have the potential to produce pearls. These nacreous pearls may be secreted in nature by different kinds of molluscs such as pearl oysters, mussels, abalones, turban, nautilus etc. All these molluscs have one feature in common, namely the possession of a layer of mother-of-pearl on the inner surface of their shells. Pearls in trade are the products secreted mainly by marine pearl oysters.

Pearl is nothing but a biochemical product of mollusc. It is produced by the accidental entrance of a foreign body inside the shell or by accidental wound inside tissue of mollusc. Pearl is secreted by the mantle, the membranous covering of soft parts, which also secretes the shell.

The pearl consists of a central nucleus surrounded by a series of pearly nacreous matter. Its substance is essentially the same as that which lines the interior of many shells, known as mother-of-pearl. The nucleus varies and it may be any foreign body, such as sand-grain, a parasitic worm or anything that acts as an irritant to the mollusc. The pearl consists of an outer coating of aragonite, calcium carbonate with distinct crystalline structure, which is cemented together by 'conchiolin', an organic substance and water. The whole thing is nacre. Some pearls may have a different crystalline structure called 'calcite' which differs from aragonite.

The molluscan shell consists of three layers, namely an outer organic layer of conchin, and two inner calcareous layers, namely prismatic and nacreous. The pearls may be built up of a single calcareous layer, two of them in any combination, or all three layers or repeated sequences of same layer.

Pearls may be produced in a natural way or by artificially inducing the mollusc to secrete nacreous matter around an inserted nucleus. The former are called natural pearls. These are formed due to natural processes or disturbances in the environment where the oyster lives. The latter category is produced by human interference and is known as a cultured pearl. Cheap imitations made of plastics that have artificial lustre are known as artificial pearls.

The chemical composition of pearl is given below (Alagaraswami, 1986) :

Water	3.97%
Organic matter	3.83%
Calcite and aragonite	91.53%
Loss	0.61%

Quality of the pearl is determined by its keratin content and colour. The latter is influenced by the colour of the shell of donor mollusc from which pallium (graft tissue) had been taken and the part from where it is extracted and implanted. The quality pearl has a specific gravity of 2.63 to 2.68 and that of inferior quality pearl is lower.

Pearl oysters and their distribution : Commercial pearls are produced by pearl oysters, which occur in seas around India. The following are the species distributed in India.

Pinctada anomioides (Reeve, 1857)

Bombay, Madras harbour, Tuticorin, and Andamans. Elsewhere: Aden, Sri Lanka, Myanmar (Mergui Archipelago) and Indonesia.

Pinctada atropurpurea (Dunker, 1852)

Madras harbour and Andamans. Elsewhere: Sri Lanka, Myanmar (Mergui Archipelago) and the Philippine Islands.

Pinctada chemnitzii (Philippi, 1849)

Madras harbour, Tranquebar, Palk Bay, Tuticorin (Gulf of Mannar), and off Balasore (Orissa). Elsewhere: Aden, Sri Lanka, Myanmar (Mergui Archipelago), Penang, Hong Kong, China Sea, Japan, Philippines, Indonesia and Australia.

Pinctada fucata (Gould, 1850)

Common Indian Pearl oyster. Gulf of Kachch and Gulf of Mannar, rare in Andaman and Nicobar Islands. Elsewhere: Red Sea, Persian Gulf, Sri Lanka and Western Pacific Ocean.

Pinctada margaritifera (Linnaeus, 1758)

It is widely distributed in the Indo-Pacific region, sparse on Indian coasts and common in Andaman and Nicobar Islands. Pearl fisheries exist in the Persian Gulf, Red Sea, Southwest Indian Ocean and Pacific.

Pinctada sugillata (Reeve, 1857)

Gujarat, Tuticorin, Madras harbour (Rao, 1970, new record) and Andamans. Elsewhere: Myanmar, Indonesia and Australia.

The Indian pearl oyster, *Pinctada fucata* is well known for the production of ornamental pearls of good colour and luster.

Although pearl oysters are distributed in various parts of India as given above, pearl fishery existed only in Gulf of Mannar and on a smaller scale in the Gulf of Kachchh. The pearl oyster beds of Gulf of Mannar are locally known as 'paars'. The pearl banks extend from Kilakkari to Cape Comorin. The central sector between Kayalpatnam and Vaippar is most productive and the fisheries are operated with the base at Tuticorin. Pearl oysters live by attaching themselves to the corals or other substrata with their byssus threads. The fisheries are irregular in nature and the fishing season lasts a month or two between January-May depending on weather conditions and oyster populations. In the Gulf of Mannar there are about 60 well known oyster beds, which extend in a 160 km. longitudinal stretch parallel to the coast. The beds cover a total area of about 2000 sq. km. and lie at a depth of 10 to 29 meters at a distance of 11 to 16 km. from the shore. The Tolairam paar near Tuticorin is the most extensive and productive. In the Gulf of Kachchh there are 42 oyster beds (locally known as 'Khaddar').

Pearl culture : There are five stages in the culture of pearl oyster leading to production of pearls.

Juvenile pearl oysters or spats are collected from the natural beds. These are then put to rest in shallow water allowing them to recover from the 'disturbance' caused to them. These are then placed in steel-wire baskets. Inner side of the basket is provided with synthetic matting or small size mesh to prevent the juvenile oyster from falling out. As the shells grow mesh size is also changed. A growth of 4.5 cm height is achieved after one year. It takes two years for the oyster to grow to the size of the mother weighing slightly over 30 gm.

During the process called conditioning the grown-up oysters are put in menthol mixed seawater. The valves get open slightly and wooden wedges are inserted inside to keep the valves open. A healthy shell of 2-4 year old is opened by cutting the muscles. A strip of mantle along its edge is cut into pieces of 2-3 sq. mm. This graft tissue, in the form of pieces, is dipped in mercurochrome, which acts as an antibiotic and prevents any disease causing germs entering the recipient.

In graft operation an incision is made near the foot and a piece of mantle with a nucleus (3.7 mm diameter) is inserted in the gonad. Implantation may also be done in mid-gut-gland

or intestine. It must be ensured that the outer layer of the mantle is in contact with the nucleus. Often two or three nuclei are implanted in one oyster. These seeded oysters are given two to three weeks time to recuperate from the operation. These are then returned to layer of rafts for post-operative rearing.

When the oysters are presumed to be ripe they are brought to the shore and examined or some times even X-rayed. After a dip in an antibiotic bath, a new sphere is inserted and the oysters are returned to the raft. Pearls so collected are washed and later polished with a soft cloth, to add more shine.

Each oyster can produce three or four pearls in its life span of about 15 years. The productive period begins at the age of three or four and lasts up to ten. Eighty percent of the pearls extracted are classified 'good to average' Freshwater pearl culture has been in practice in China and Japan, in mussels *Cristataria plicata* and *Hyriopsis schlegelii* respectively.

In freshwater pearl culture the mussels are conditioned in cement or plastic tubs for 5 to 7 days without feeding so as to render them supple for surgery. Shell beads are preferred as nuclei; locally made ceramic beads are also used. The operated mussels are stacked in nylon cages and set on the pond bottom at a depth of 1.0 to 1.5 m. Pearls are harvested after 2 to 3 years.

Preparation of host shell : In nature pearls may be formed in different regions of the body namely near the region of adductor muscles, mantle margin, pallial zone etc. The best site for pearl production is considered to be the gonadial region. Spent individuals i.e. individuals whose gonads are devoid of gametes, serve as good hosts. Nucleus is inserted in the gonadial region.

Nucleus insertion : It involves selection of a suitable donor shell or any other object for obtaining the nuclear material and donor oyster or mussel for obtaining graft tissue. Nuclei are obtained from shell of sacred chank, ceramic beads etc.

Graft tissue has to be obtained from the pallial zone of a selected oyster or mussel. This operation has to be conducted very carefully without causing much injury to the bivalve concerned. In *P. fucata*, 2 to 3 sq mm pieces of graft tissue are obtained. The size of the nucleus determines the size of the graft tissue. Usually 2 to 3 mm-size nuclei are used in marine pearl culture.

After obtaining the nucleus and graft tissue the recipient oyster will be operated upon and the nucleus is implanted in the gonadial region. The time and number of nuclei to be implanted will be determined in advance.

Convalescence : After operation the mussels are allowed to recover from the disturbance caused. The oysters are kept in cages consisting of 68 x 60 x 30 cm heavy wire frames covered with fine wire-mesh.

Pearl formation : The graft tissue on the nucleus grows into a pearl sac. The epithelial cells of the pearl sac deposit nacreous layer around the nucleus, which ultimately leads to the formation of a pearl. In pearl oysters it takes three to four years for pearls of commercial value to develop. In freshwater mussel pearls are harvested 2-3 years after implantation.

Harvesting : Oysters or mussels with pearls are brought to the laboratory. The valves are opened and the fleshy parts are extracted out. The pearls are obtained by pulverising the extracted part.

Processing of pearls : Soon after their separation from the meat, pearls are washed with water to remove the mucilaginous matter and maintain the luster. The pearls are then graded according to size.

Quality of pearls : The quality pearl has luster and is free from spots or marks. Nearly rounded pearls are valued high and find ready market. Baroque or teardrop shaped pearls fetch less prize. Pearls come in different shades - deep blue, gray, pink-yellow, orange and white, but creamy white is regarded as the best colour. Black pearl is rare and it is much sought for.

An imitation pearl, which usually consists of a mother-of-pearl bead coated with fish scales or plastic, will feel smooth if we rub it gently on our front teeth. A real pearl whether they are cultured or natural will feel slightly rough, though it may look and feel smooth on our fingers.

If the pearls are to last long they should be wiped carefully with a soft cloth after each wear. Occasionally it should be washed with soft detergent, rinsed in water and dried gently.

Pearls of medicinal value are obtained from windowpane oyster, *Placenta placenta* in the Gulf of Kachchh. These are small and known as seed pearls. These are used in the preparation of Ayurvedic medicine called *Mukta bhasma*. Large beds of windowpane oyster occur in the Balapur Bay and Pindara Bay of Gulf of Kachchh.

Use of pearls : Pearls had seized the imagination of creative artists and writers. These are 'classics' for fashion minded people. Diamonds are the costliest of all gems. But in the beginning of the last century pearls were popular because of their scarcity. In the earlier days pearls were practically the exclusive preserve of the rich and royal families. During fifties of the last century pearls became part of the routine wearing of genteelly reared upper and middle class women. Hollywood actresses Grace Kelly wearing a string of pearls in the film 'High Society' and Audrey Hepburn sporting pearls in 'Breakfast at Tiffany' have influenced a number of women to imitate them. Depending on their place of provenance pearls have been sold at unimaginably higher prices. Elizabeth Taylor purchased 'La Peregrine' in New York in 1969 for \$ 37000. The pearl necklace was originally presented by Phillip – II of Spain to Mary Tudor in 1554. Cultured black pearls in the world market cost from \$ 1700 or \$ 10000 to \$ 13000 depending on the size and quality of the pearl. Ciro is one of London's most prominent pearl retailers. Its manager Jane Dawson says 'most popular is the single short row of pearls between 9 and 15 mm in diameter. Princess Diana for instance used to wear 10 mm pearls. Fashionable women are buying 15 mm and a lot of women inspired no doubt by Barbara Bush are buying three strand chokes'

In her exhaustive manual, *Elegance*, Genevieve Antoina Dariaux comments 'The ideal necklace, the most universally becoming piece of jewellery ever created, and an indispensable accessory in every woman's wardrobe, is a string of pearls. Every woman should own a single-strand pearl necklace and a second one of three or five strands. If she is a grand dame of a certain age, she can even wear seven or nine strands. Like roses in a vase, an odd number is

more elegant than even one' Fashion-conscious western women are going in for pearls. In India too pearls are popular among women folk. It is the second largest importer of pearls in the world only after Lebanon.

Central Marine Fisheries Research Institute has done very good work on pearl culture in India. For further and more detailed information on pearl oysters and pearl culture one may refer to Alagarwami (1986).

2.3. Shellfish of Gastronomic Value

Several species of marine and a few of freshwater and land molluscs are eaten in many parts of the world and in India too. There is a regular fishery of some of the marine species and even culture techniques have been developed to augment their production in India. Among marine molluscs, oysters, clams, mussels, and cephalopods are considered as gastronomer's delight. According to FAO Year Book of Fishery Statistics, 1970, molluscs constitute 5.14 per cent and crustaceans 2.30 per cent of the average annual world fishery production. In India mollusks constitute about four to five per cent of the fish landings (Appukuttan, 1996).

The value of any edible resource depends on its nutritive content, popularity among the people, harvesting facility and the quantum of yield.

The nutritive value of different edible molluscs is calculated on the basis of the chemical composition of its flesh, which is as given below (Alagarwami, 1973).

	Water Content	Protein	Fat	Carbohydrate	Ash
Clams	75.28	10.33	2.10	3.75	2.06
Oysters	76.85	11.18	1.97	8.00	2.02
Cockles	89.01	5.32	0.35	2.05	-
Blood clams	76.30	12.30	1.40	7.20	2.80
Scallops	80.30	14.80	0.1	3.4	1.4
Mussels	84.20	8.70	1.1	4.1	1.9
Pearl oysters	74.00	19.80	2.5	2.5	2.0

From the analysis it is clear that molluscs are a valuable source of protein and some are known to contain vitamins and minerals.

2.3.1. Popularity : Molluscs as food are popular in Japan, Europe and U.S.A. Snail is a delicacy in France, which is the single largest consumer accounting for 67 per cent of EEC's global imports. In India molluscs are not as favourite a food as fish or crustaceans. Molluscs are eaten by poor people living along the coastal belt. However marine molluscs are very much relished by the aborigin tribes of Andaman and Nicobar Islands. In some parts of northern and eastern India freshwater molluscs are eaten. Molluscs have nutritional advantage because of their easy digestibility and high content of minerals and vitamins.

2.3.2. Methods of Harvest : Capture of molluscs is simple and since many of these molluscs, except cephalopods, are sedentary and live close to the shore harvesting becomes easy.

2.3.3. Production : Squids, octopuses and cuttle fishes constitute about one third of the total production of molluscs. The average annual production of cephalopods in India from 1962 to 1971 is only about 780 tons. These are caught along with other fishes and no specific capture fishery exists for these molluscs. Although many species of cephalopods are involved, the main commercial species in the Gulf of Mannar is the Palk Bay Squid, *Sepioteuthis arctipinnis*.

Clams, mussels and oysters are the most abundant resources of our country and their production levels can be increased by simple transplantation experiments and culture techniques. CMFRI has started culture of molluscs at Vizhinjam, Tuticorin, Mandapam, Madras and Visakhapatnam, which has shown promising results. Qasim *et. al.*, (1977) had shown that the technique of rope culture in case of mussels could yield 480 tons per hectare per year.

The edible mollusks include mainly bivalves such as edible oysters, mussels and clams, and a few species of gastropods namely *Babylonia spirata*, *B. zeylanica*, *Chicoreus virgineus*, *Pleuroploca trapezium* etc. The gastropods are exploited mainly for meeting the export market of Southeast Asia (Appukuttan, 1996).

2.4. Biomedical Value

Molluscs have been used in the preparation of ayurvedic and homeopathic medicines from a long time. Extracts are prepared from powdered oyster shell (*Crassostrea* sp.) and also from cowry shell (*Monetaria moneta* and others) for use in homeopathic medicines. Operculum of *Pugilina cochlidium* is used in the preparation of certain Unani drugs. *Sankha bhasma*, *Mukta bhasma* and other mollusc preparations are used in ayurvedic drugs. *Sankha bhasma* is used against ailments ranging from skin diseases to rickets and asthma. Chank powder in short is a panacea for diverse illnesses like jaundice, cough and general debility. Dried visceral mass of chank is thought to be efficacious for enlarged spleen.

A large number of marine invertebrates are known to provide leads to some biologically active compounds. Among these, molluscs have been considered as one important group. In the dynamic and complex marine ecosystem, molluscs are under constant struggle for securing food, for procreation and for their very survival. To meet these challenges, molluscs have developed various devices and defensive adaptations, of which chemical armament in the form of secretions is significant. Biomedical potential of molluscs lies in their secretions, which may originate from the dermal region or from internal glands.

Mucus is secreted in different parts of molluscan body, such as in the pedal region, in the body surface and in glands. The secretion from *Onchidium verruculatum*, of marine habitat, on screening was found to have antimicrobial activity. The secretions from chiton, *Ischnochiton comptus* have yielded bioactive compounds, which have shown antifertility activity.

Secretions in many prosobranchs, especially in the carnivorous species belonging to the families Muricidae, Buccinidae, Conidae and others contain toxic compounds. These secretions from the hypobranchial glands contain prominently choline esters (Endean, 1972).

Sea hares have been found to be potential sources of valuable biomedical compounds. *Aplysia benedicti* and *Aplysia dactylomela* are two species occurring off Indian shore. The digestive gland secretions of these species display hypoglycemic activity. Halogenated metabolites are obtained from their secretions. Brominated indoles are known for their antimicrobial activity. The possibility of using dolstatins in the secretions of sea hare as anticancer compounds is under investigation. The sea hare secretes an unstable red dye called aplysiopurpurin, which contain chromoprotein. It is secreted in the Blochmann's gland in the mantle shelf. A large amount of mucus is also secreted along with the dye. This purple secretion is joined by the secretions from an opaline gland (poison gland) located in the floor of the mantle cavity. The toxin from the Blochmann's gland of two exotic seahares (*Aplysia vaccaria* and *A. californica*) is water and acetone soluble. The toxin causes muscular weakness and death in mice and chicks (Winkler, 1961 in Russell, 1965).

Cones are well known poisonous molluscs. Cases of humans getting affected by the conus venom were reported from several parts of the Indo-Pacific, like Great Barrier Reef, West Pacific and from the Red Sea (First record in 1978). However, there are no such records from India. The latest studies on the chemical nature of conus venom reveal that the active principles are peptides. Paralysis of prey organism is probably due to the direct effect of poison on nerves, mainly of the peripheral nervous system (Kohn, 1983). The toxicity of the venom varies with the species and also with the part of the duct from where the secretions originate (Russell, 1965). Biochemical properties of cone poison were studied (Endean and Rudkin, 1963; Cruz *et al.* 1976, 1978). The effect of poison of *Conus amadis* on fish was studied in India (Rajendran and Kasinathan, 1987).

Conus venom contains a wide variety of complex neurotoxins. Genes controlling the toxins looked very different and they had been changed by fairly recent mutations. Cone snails have the fastest evolving genes known. "The rapid evolution probably leads to substantial variation in venom effectiveness against particular prey" (Anon, 1999).

Recently an Australian researcher from Wollongong University had isolated a new antibiotic from the eggs of common dog whelk (*Nassarius* sp.). The new antibiotic was found to be effective against marine bacteria and against human pathogens including *Staphylococcus*, *Entamoeba coli candida* and the bacteria that cause pneumonia. Reserachers believe that there are other molluscs, which may have powerful anticancer and antiviral properties (Anon, 2000).

The secretions from the posterior salivary glands of dibranchiate cephalopods are toxic to some crustaceans and fishes. The secretion appears to be a mixture of several substances such as biologically active amines, enzymes and non-enzymatic polypeptides (Boucaud Camou and Boucher Rodoni, 1983). The biologically active component of the cephalopod toxin is identified

as cephalotoxin, a glycoprotein (Fisher *et al.* 1956b; Ghiretti, 1959). The venom of the blue ringed octopus *Hapalochlaena maculosa*, whose bite is lethal to man, contains maculotoxin, identified as tetrodotoxin (Sheumack *et al.*, 1978).

The secretion from the ink gland of cephalopod is used in homeopathic preparations. The secretion is a colourless fluid containing a suspension of dark brown or black particles. It contains the pigment 'sepia', which is a typical melanin possibly conjoined to protein. In India the source is mainly from *Sepioteuthis arctipinnis* (the Palk Bay squid).

Vitamin A was reported from nine species of marine bivalves (e.g. *Mytilus edulis*, *Ostrea edulis*, *Mya arenaria* etc.), eighteen species of gastropods and cephalopods. It was concentrated mainly in the digestive gland or in the visceral mass in the case of gastropods and bivalves, and in the liver of cephalopods (mainly as ester) (Cariello and Zanetti, 1977).

Recent investigations had shown that nonvenomous bivalves were also potential sources of important bioactive compounds. They were found to be potential sources of anticancer drugs (Endean, 1972). Antimicrobial substances were isolated by Li (1960) from some marine bivalves and anti-cancer compound named mercenaria was obtained from a venerid clam, *Mercenaria mercenaria* (Schmeer *et al.* 1966). Glandular extracts from *Perna canaliculatus* and other species of Mytilacea were used for arthritis treatment. There are two species of *Perna* distributed along our coast and also a number of species of venerid clams, which on investigation may turn out to be sources of pharmacologically active substances. Recent interest in the exploration of drugs from the sea has focused attention on a number of marine invertebrates including molluscs. Screening of these marine organisms for bioactive substances was carried out at various centres in India viz. National Institute of Oceanography (Goa), Central Drug Research Laboratory (Lucknow), Bose institute (Calcutta), Andhra University (Visakhapatnam) and Regional Research Laboratory (Bhubaneshwar) of Council of Scientific and Industrial Research (Parulekar, 1990).

2.5. Marine Biodeterioration

A number of marine bivalves bore into hard substances, such as wood, rock, etc. They enter these substances as young larvae by boring a canal and settle there. As the larva grows in size it widens the canal. They get lodged inside the substance, as they cannot quit the wood or rock anymore, as the exterior opening is too small. The boring is facilitated by the rough exterior of the shell. Where the boring bivalves attack man made structures they cause considerable damage.

India has a vast coastline, and a number of wooden structures like jetties, piles etc. are erected in coastal waters. Besides, catamarans, fishing vessels, boat building yards and several installations of the Indian Navy are constructed out of wood. All these structures and even the living mangrove vegetation are prone to attack by the foulers and borers. The losses incurred due to damage by marine borers are enormous. It is estimated that the fishing industry alone suffers a financial loss of more than 120 million rupees annually. The magnitude of the problem of biodeterioration is such that in spite of several years of research it has not been possible to

totally eradicate or control these foulers or bores. The establishment of a Wood Biodeterioration Centre (Marine) under the Institute of Wood Science and Technology (Indian Council of Forestry Research and Education) points to the significance of this problem of marine biodeterioration.

There are several animal groups that form the community of marine foulers and borers. Molluscs are important constituents of this community. Bivalve molluscs are the most successful as foulers and borers. Fouling molluscs include most of the byssus-bearing bivalves like mytilids, dreissenids and epifaunal forms like oysters, anomids etc. *Perna viridis*, *Perna indica*, *Saccostrea cucullata*, *Crassostrea cuttackensis* and *Mytilopsis adamsi* are some of the species found along our coast. The last mentioned species is an introduced one. It is reported from Bombay (= Mumbai) Visakhapatnam harbour and Kakinada port area.

Marine wood borers include 30 species of shipworms (Teredinidae) and nine species of piddocks (Pholadidae) and crustaceans. The piddocks are capable of boring into soft or sand stone or even into brickworks. They occur in typical marine habitat extending into brackish waters also. The following are the common and widely distributed species of India (Santha Kumaran, 1994): *Bankia campanellata*, *Bankia carinata*, *Bankia rochi*, *Dicyathifer manni*, *Nausitora hedleyi*, *Lyrodus pedicellatus*, *Teredo clappi*, *Teredo furcifera*, and *Martesia striata*.

There are peanut shells (Lithophaginae), which bore into corals and cause damage in the coral reef ecosystem (Appukuttan, 1974).

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3. SYSTEMATIC ACCOUNT

Class : POLYPLACOPHORA

These are commonly known as chitons or 'Coat of Mail' shells. The animal is bilaterally symmetrical and dorso-ventrally flattened. The body is shielded dorsally by eight articulating shell plates or valves arranged in an overlapping series. The shell facilitates a chiton to roll into a ball when disturbed. The shell plates are surrounded by a girdle or peritoneum. The girdle may be smooth or covered with calcareous scales or spines. A strong, broad and flat muscular foot is present on the ventral side. The foot is used in creeping locomotion or in attaching to substrate. Foot is bordered laterally by a pallial groove enclosing a variable number of double feathered gills or ctenidia. Anteriorly the mouth opens in front of the foot. The head is not quite distinct. There are no eyes or tentacles. There is a well-developed radula with 17 transversely placed teeth. The intestine is coiled and opens posteriorly through a terminal anus.

The sexes are separate and without any external differentiation. There is a pair of gonoducts without connection to the pericardium. A pair of nephridia extends from the pericardium to the gill-bearing groove. A free-swimming larva emerges out of the egg.

Chitons are exclusively marine, and mainly tropical, with a few species in the temperate seas. These are mainly shallow water herbivores grazing on algae and living attached to rocks, empty shells or other hard objects. A few species extend into great depths. A total of 500–600 species are estimated globally. In India about 30 species are reported so far. These were reported mainly from Andaman and Nicobar Islands, Lakshadweep, Gulf of Mannar, Palk Bay, Gujarat coast and Visakhapatnam on Andhra coast. Chitons in India have size ranging from 15 mm to 100 mm in length.

Chitons are identified by the external characters of body and shell. The nature of girdle, shell valves and the arrangement of gills are important taxonomic characters that distinguish the species. The outermost layer of the shell is periostracum, beneath which is found the tegmentum. The innermost layer is articulamentum. The outer ends of the articulamentum that lie under the lateral triangles are termed insertion plates as they attach the valves to the mantle. The insertion plates bear a number of teeth. The first and last shell valves differ from the intermediate valves in shape and also in sculpture. The anterior most or first valve has a semicircular base and a straight posterior margin. It does not possess any apophysis. The posterior most or tail valve is semicircular to half elliptical. It has a top, called mucro, the position of which is variable. A diagonal line or elevated ridges radiate from the mucronal area dividing the valve into distinct areas. The intermediate valves are quite distinct from the anterior and posterior valves. The valve is differentiated into a central area and lateral areas, which have distinct sculpture. Each valve bears two apophyses separated by a jugal sinus. The surface area is generally differentiated

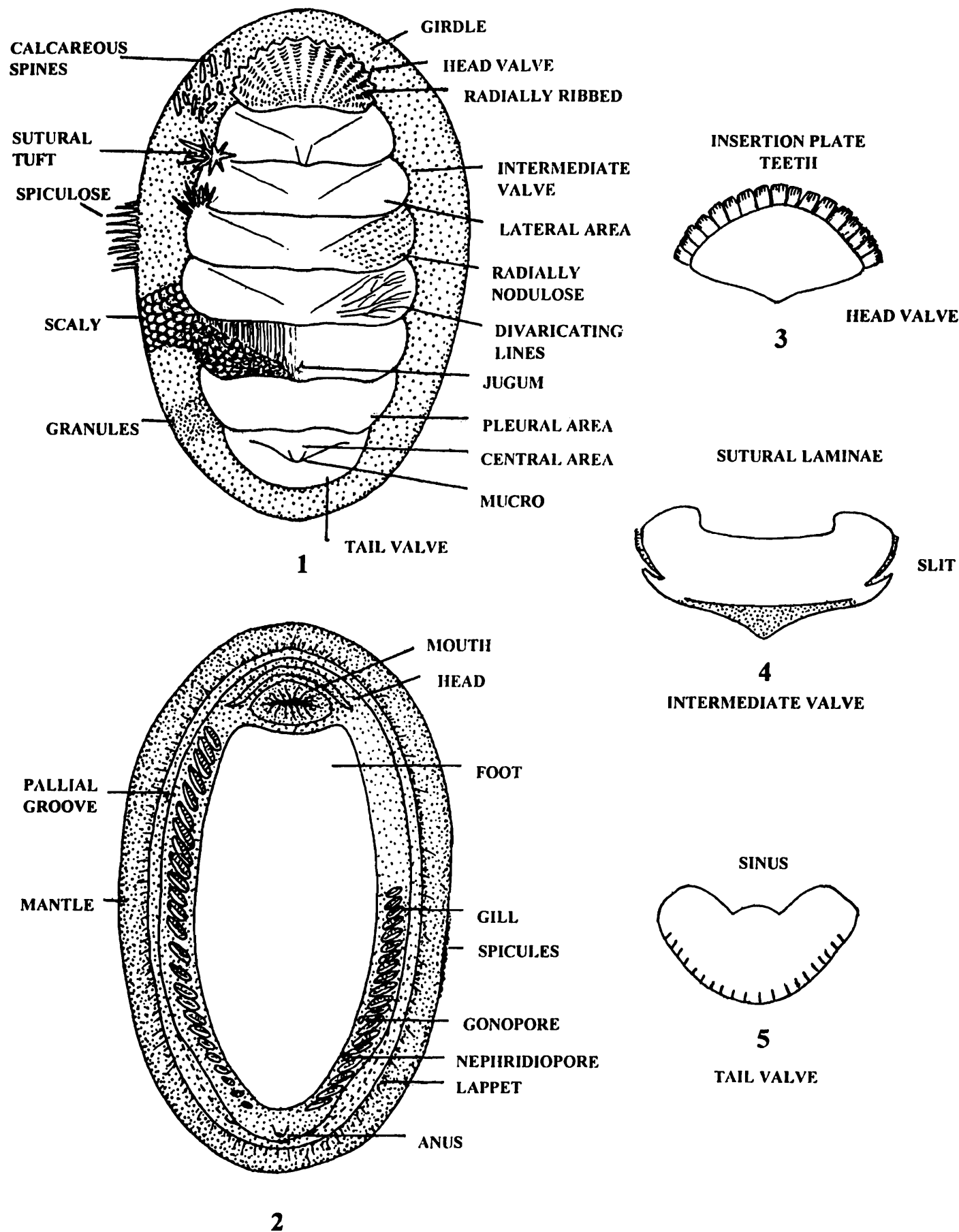


Fig. 16. Chiton : External characters.

1. Dorsal View; 2. Ventral View; 3. Head Valve; 4. Intermediate Valve and 5. Tail Valve.

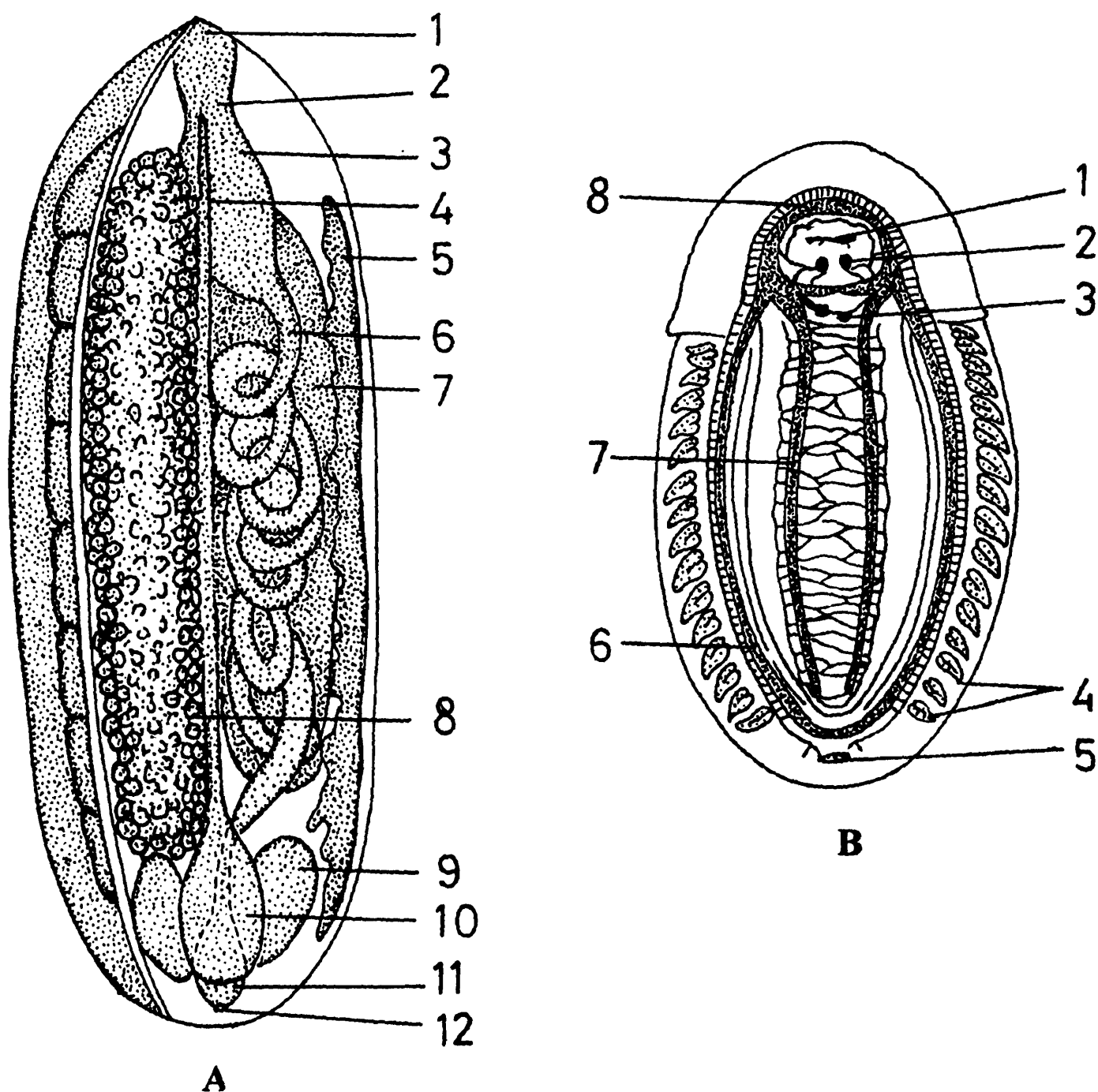


Fig. 17A. Chiton : Internal organs

1. Buccal mass; 2. Oesophagus; 3. Stomach; 4. Dorsal blood vessel; 5. Kidney; 6. Intestine; 7. Liver; 8. Gonad; 9. Auricle; 10. Ventricle; 11. Rectum and 12. Anus.

Fig. 17B. Chiton : Nervous system

1. Mouth; 2. Buccal commissure; 3. Subradular commissure; 4. Gills; 5. Anus; 6. Pallio visceral nerve cord; 7. Pedal nerve cord and 8. Cerebral commissure.

into a median and two lateral triangles by the presence of a diagonal line or rib. The median and lateral triangles bear distinct sculpture. The girdle encircles the shell valves and varies in width in different families. Dorsally it may bear calcareous spines, spicules or scales.

The arrangement, number and size of the gills are useful in the identification of species. These are arranged in a longitudinal row in the pallial groove. These may extend from the anterior to the posterior end or may be restricted to the posterior region only. The former condition is described as holobranchial and the latter as merobranchial. The size may increase from anterior to posterior end and the two rows of gills on either side may be separated from each other and the anus by a space. In some, the gills may decrease in size towards the posterior end. The former arrangement is described as abanal and the latter adanal. The presence or absence of space in relation to anus is described as ababal with interspace and adabal without interspace.

There has been some consistency in the classification of class Polyplacophora, although with slight variations above the family level. Boss (1982) classified all the living chitons under the subclass Neoloricata and divided it into three orders, namely Lepidopleurida (3 families), Ischnochitonida (9 families) and Acanthochitonida (1 family). Kaas and Van Belle (1985), in their revision of chitons, relegated Neoloricata to the level of an order and the three orders mentioned above to suborders. We have followed the latter in the present treatment and all the three suborders are represented in India.

Key to families

1. Insertion plates absent, or when present not slit into teeth LEPTOCHITONIDAE *
- Insertion plates present on all valves 2
2. Insertion plates finely grooved on the outside CHITONIDAE
- Insertion plates not grooved but with variable number of slits 3
3. Girdle with specialised tufts of spinelets but never scaly, gills not extending the full length of the foot ACANTHOCHITONIDAE
- Girdle smooth to spinose but not arranged in tufts 4
4. Insertion plates sharp edged with several slits, girdle scaly or hairy ... ISCHNOCHITONIDAE
- Insertion plates thick, with a few slits, girdle with setae or scaly 5
5. Insertion plates thick, with a few slits, girdle hairy or bristles of varying lengths, but never with scales, without eyes MOPALIIDAE
- Insertion plates with 6-10 slits, rows of large eyes along the ribs of valves, girdle with scales SCHIZOCHITONIDAE *

* Not dealt in this book

Order **NEOLORICATA**Suborder **ISCHNOCHITONINA**Family **CHITONIDAE**

Animals small to large, sometimes attain about 100 mm length, sculptured with concentric or radial ribs, valves with or without true eyes, sutural plates separated by a sinus that has notches along the edge, insertion teeth pectinate, i.e. subdivided into smaller teeth, valve second to seventh with one or three slits, and with well developed apophyses, girdle naked and leathery, or has well developed, solid, rounded and closely overlapped scales, or with spines or spicules.

There are numerous species in tropical and subtropical waters. Three genera and about eight species are reported from India. Only those species, for which collections are available, are treated in this book. *Tonicia fortilirata* (Reeve) was reported from Krusadai Island, but in the absence of any material we are unable to establish the status of the species.

Seven species of the genus *Chiton* were reported from India but only four for which collections available are dealt here.

Chiton granoradiatus Leloup, 1937

(Fig. 19.1)

Shell small, up to 30 mm in length, yellowish with brown tinge, sides of plates stretched out and gradually sloping down. Girdle whitish, leathery with numerous small, oval, and slightly convex, milky-white tubercle-like imbricating scales. Head valve slightly larger than the tail valve, and bears about forty regular, close-set, slightly flattened and finely granulose radiating riblets with narrow interstices between them. Tail valve slightly concave, bearing lesser number of riblets (about thirty) than the head valve, mucro or beak median, anterior end depressed. Intermediate valves with well demarcated median and lateral areas, the former bears about eighteen to twenty regular, well arranged short, broad, prominent, close-set and finely granulose longitudinal riblets running parallel to the jugum; lateral areas raised and look like isosceles triangles, each bearing five to seven very large, broad, flattened, rather distantly placed, finely and profusely granulose and anastomosing radiating ridges or costae, interstices slightly wide and shallow.

India : Maharashtra : Bombay; Tamil Nadu : Tuticorin; Andhra Pradesh : Visakhapatnam; Andaman and Nicobar Islands, attached to rocks in the intertidal region.

Spawning behaviour of the species was studied in laboratory (Nagabhushanam and Murti, 1969). Spawning extended from March to July. No spawning was observed in nature and there seemed to be no impact of lunar changes. It may have a semi-annual reproductive cycle.

Association of mature individuals of both the sexes, salinity (32.60% to 35.53%) and temperature (27° C to 29.8° C) were the possible factors to induce spawning.

Synonym : *Chiton tuticoriensis* Ray and Roychowdhury, 1968.

Chiton hululensis (Smith, 1906)

(Fig. 19.2)

Terminal valves concentrically ridged. Intermediate valves with smooth median areas and with undulating ridge-like structures on the lateral areas.

India : Lakshadweep, Andamans. Elsewhere : Red Sea, Maldives : Hulule Islands; Indonesia.



Fig. 18. *Acanthopleura spiniger* on rock, Chidiatapu, S. Andaman.

Chiton pulcherrimus Sowerby, 1841

(Fig. 19.3)

Shell small, up to 20 mm, a beautiful species. Intermediate valves with somewhat angularly raised median area and with nodulose ribs prominently radiating on the lateral areas. Anterior

most valve with radiating lines of granules, last valve with depression in the middle and with radiating granules posteriorly. Girdle with typically fine and smooth scales.

India : Nicobars. Elsewhere : Vietnam, Australia, Philippines.

***Chiton iatricus* Winckworth, 1930**

(Fig. 19.4)

Animal large, up to 65 mm in length, oblong oval. Shell with subdued sculpture, a marked ridge separates the lateral areas from the median area, anterior margins of the valves with well marked growth lines, the head valve with eight slits and tail valve with about twelve slits, sutural laminae strong and the sinus pectinate. Colour reddish brown with dark red markings on a yellowish fawn background, the same two colours alternate in bands on the girdle, but in preserved specimens seen as distinct bands on the girdle.

India : Gujarat : Port Okha, Porbander and Veraval. It has limited range in distribution extending from Gujarat to Karachi (Type-locality) in Pakistan.

***Chiton imitator* Nierstrasz, 1905**

(Fig. 20.7)

Shell small, up to 25 mm in length. Anterior most valve semicircular, and with three transverse rows of granules anteriorly. The second valve slightly larger than other valves, rough and without any demarcation of areas and also without sculpture. Rest of the middle valves narrow. Posterior-most valve slightly depressed. Girdle narrow and covered by small, ovate, closely arranged scales and gills extending the whole length.

India : Andaman and Nicobar Islands. Elsewhere : Indonesia, N. W. Australia, Timor, Indo-China.

***Tonicia pectinoides* Sykes, 1903**

(Fig. 20.5)

Shell small, moderately broad and surrounded by a narrow girdle. Lateral areas of the valves distinct and elevated, valves sculptured with broad and strongly developed longitudinal ribs on the central areas and on anterior part of the valve, interstices between these ridges traversed by minute transverse riblets, anterior head valve, posterior part of the anal valve and lateral areas of intermediate valves with rows of flattened nodules, the number fewer and more widely separated on the intermediate valves, insertion plates with well developed slits, colour pale yellowish brown on the valves and tinged with green in the girdle.

India : Tamil Nadu : Krusadai Island. Elsewhere : Sri Lanka.

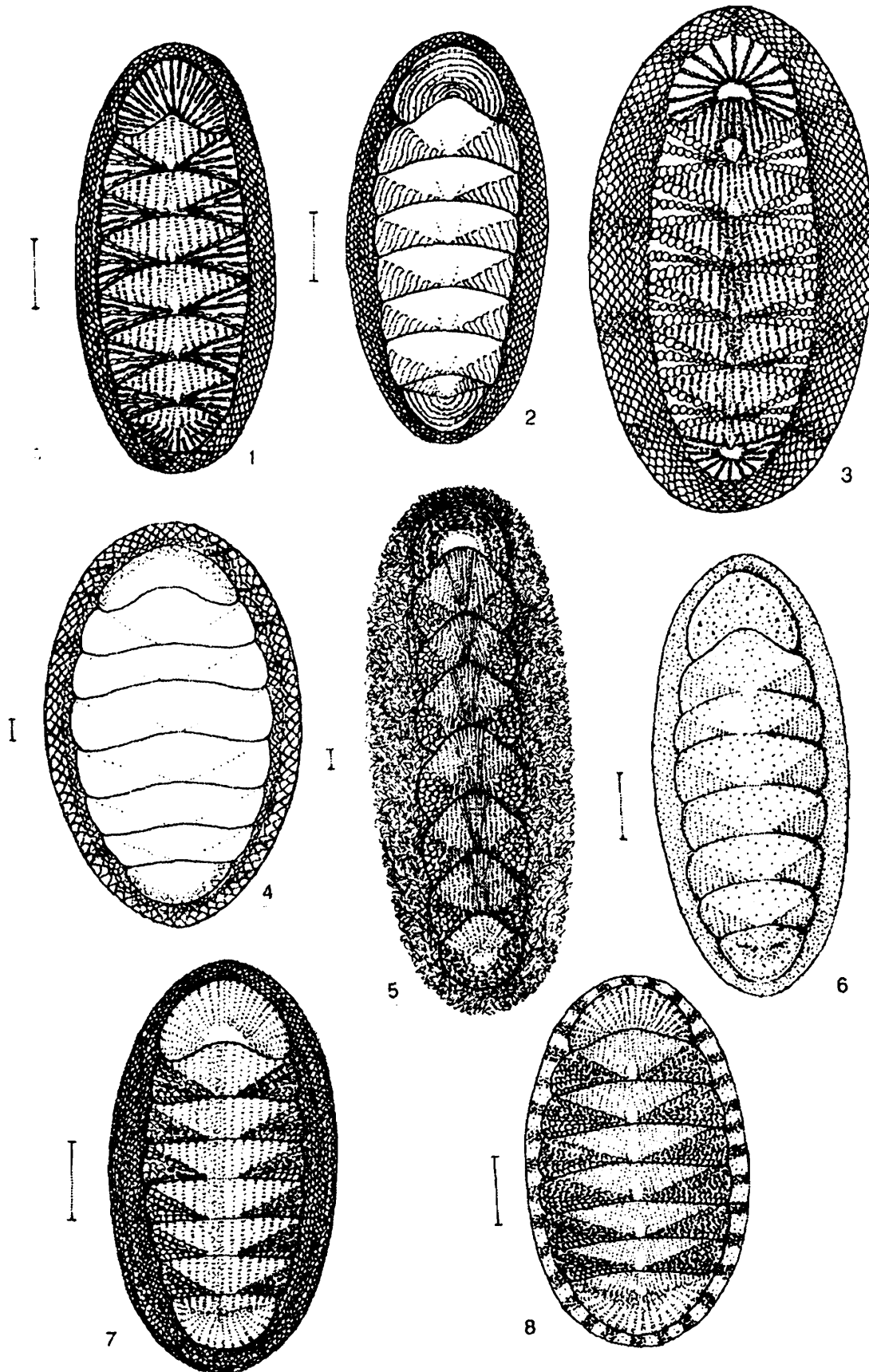


Fig. 19. Chitons. Different species of Chitons.

1. *Chiton granoradiatus* x7; 2. *Chiton hululensis* x7; 3. *Chiton pulcherrimus* x7; 4. *Chiton iatricus* x2;
 5. *Ischnochiton alatus* x2; 6. *Ischnochiton bouryi* x7; 7. *Ischnochiton comptus* x8; 8. *Ischnochiton winckworthi* x7.

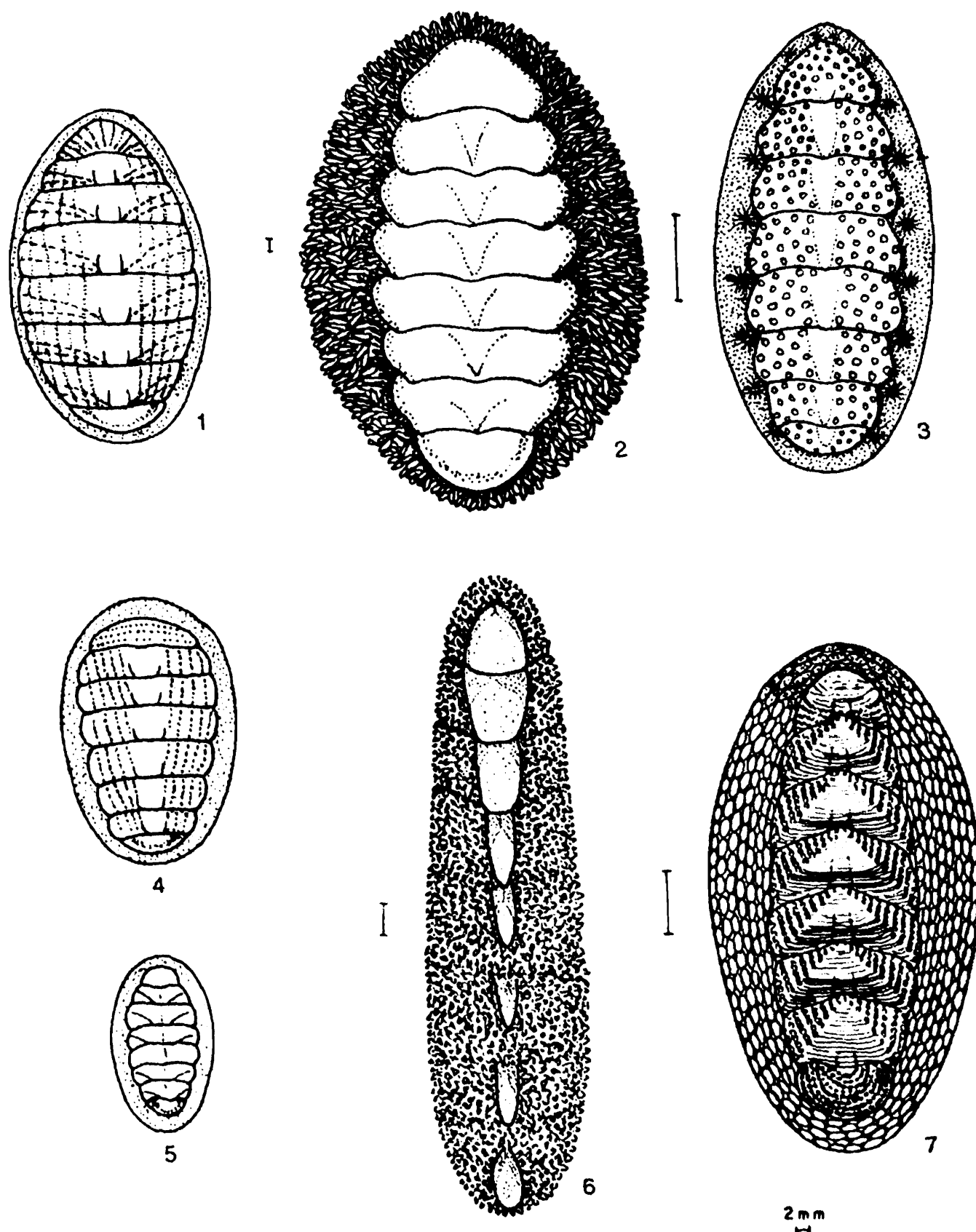


Fig. 20. Chitons. Different species of chitons.

1. *Plaxiphora tricolor*, 2. *Acanthopleura spiniger*; 3. *Acanthochitona mahensis* x8, 4. *Craspedochiton laqueatus*, 5. *Toricia pectinoides*, 6. *Cryptoplax larvaeformis* and 7. *Squamopleura imitator* x6.

Acanthopleura spiniger (Sowerby, 1840)

(Figs. 18 and 20.2)

Thorny Chiton, largest of Indian chitons, up to 70-75 mm in length. Girdle with numerous curved spines. Shell large and rounded, with thick and heavy valves, sculpture on the valves obsolete.

India : Andaman and Nicobar Islands, common, attached to rocks in the intertidal region. Widely distributed in the Indo-Pacific.

Family ISCHNOCHITONIDAE

Animal small to medium in size, not more than 60 mm in length. Tegmentum of the valves 2-7 usually divided into lateral and central areas by a diagonal rib. Lateral areas usually markedly elevated, shell sculpture variable, reticulate and costate. First and last valves have multiple-slitted insertion plates, the intermediate valves have either a single slit or in some group two or more slits in each side.

Two genera *Ischnochiton* and *Stenoplax* are reported here. The former has cosmopolitan distribution with more than 100 species, lateral areas raised and sculptured, tail valve with a well-developed pointed projection or mucro. Girdle has imbricated and generally striated scales.

Ischnochiton bouryi Dupuis, 1917

(Fig. 19.6)

Animal of moderate size. All the valves of equal width, tegmentum grayish brown in colour, anterior most valve semi-oval, with a broadly V-shaped posterior margin, surface granular, intermediate valves hexagonal, with almost straight posterior margin, lateral areas raised, uniformly granular, tail valve semi-oval, well developed mucronal area with a distinct post mucronal area. Girdle narrow. Gills holobranchial and abanal.

India : Gujarat : Gulf of Kachchh; Tamil Nadu : Gulf of Mannar; Andamans. Indo-Pacific.

Synonyms : *Ischnochiton aequigranulatus* von Knorre. (Satyamurti, 1952)

Ischnochiton (Haplaplax) comptus (Gould, 1859)

(Fig. 19.7 and 19.8)

Animal of moderate size, length 9.5 to 11.5 mm, maximum width 6.5 to 7 mm, oblong ovate and somewhat flattened. Valves differentiated into central and lateral areas, central area with

minute, regular granulations, lateral area with radiating ridges broken into tubercles. Anterior head valve and posterior tail valve distinctly sculptured. Dorsal surface of the intermediate valves bears three distinct bands in the centre. Gills holobranchial and abanal. Girdle with closely packed scales.

India : Tamil Nadu : Gulf of Mannar (Shingle Island); Andamans. Lives attached to dead shells or other hard objects. Indo-Pacific.

Synonym : *Ischnochiton winckworthi* Leloup, 1936

***Stenoplax (Stenoplax) alata* (Sowerby, 1841)**

(Fig. 19.5)

Animal of moderate to large size, length 25.5 to 37.5 mm, maximum width 12.5 to 16.2 mm. All valves of equal width and without beak, tegmentum grayish brown in colour. Anterior-most valve semi-oval, with a deeply V-shaped posterior margin. Intermediate valves hexagonal, valve as long as wide. Anterior and posterior valves concentrically ridged. The intermediate valves with lateral and central areas demarcated by oblique ridge like elevation, lateral areas with longitudinal ridges. Well-developed mucronal area and a well demarcated post mucronal area. Articulamentum weakly developed. Girdle wide. Arrangement of gills holobranchial and abanal.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands. Indo-Pacific.

Synonyms : *Ischnochiton herdmani* Sykes (Satyamurti, 1952)

Ischnochiton alatus (Sowerby)

Suborder ACANTHOCHITONINA

Family ACANTHOCHITONIDAE

Mantle smooth or hairy but not scaly. Gills do not extend the full length of the foot. Insertion plates slitted, number of slits 5 on the first valve, tegmentum absent.

Subfamily ACANTHOCHITONINAE

***Acanthochitona mahensis* Winckworth, 1927**

(Fig. 20.3)

Animal small, length 10.6 to 12.5 mm, width 4.1 to 8.5 mm, intermediate valves not well demarcated into central and lateral area, uniformly granular but smooth in the centre, lateral edges of the shell plate covered by the girdle, insertion plates small but with distinct slits. Girdle fairly broad and extensive, about eighteen tufts of bristle-like spicules arranged at equal intervals on the dorsal side, ventral side of the girdle smooth. Valves pale pinkish in colour. Gills holobranchial and abanal.

India : Mahe, Tamil Nadu : Gulf of Mannar; Andhra Pradesh : Visakhapatnam; Orissa : Gopalpur; Nicobars.

Craspedochiton laqueatus (G.B. Sowerby, 1841)

(Fig. 20.4)

Animal broadly ovate. Valves not clearly differentiated into central and lateral areas, weakly keeled along the middle line, uniformly coarse granulations on either side of the median keel. Anterior valve with weak radiating ribs and granulations. Posterior valve small, mucronal area feebly developed. Insertion plates slitted, number of slits 5 on the first valve, tegmentum absent. Girdle narrow, dorsally with numerous close-set processes, ventral margin slightly thickened. Mantle smooth or hairy but not scaly. Gills do not extend the full length of the foot.

India : Tamil Nadu : Gulf of Mannar.

Subfamily CRYPTOPLACINAE

Mantle smooth and gills do not extend the full length of the foot, animal of vermiform shape, valves reduced and separated, only slightly exposed.

A single genus, *Cryptoplax* that includes nine species, is distributed in the Indo- Pacific region. Three species are reported from India.

Cryptoplax larvaeformis f. occulatus (Quoy & Gaimard, 1834)

(Fig. 20.6)

Worm-like chiton, moderately large, length 31 to 32.5 mm, width 12.5 to 14.5 mm. Valves very much reduced and narrow, embedded in a large fleshy and densely spiculate girdle, the first four valves generally in contact, fifth a little separated and slightly smaller than the fourth, the sixth further apart and very small, the seventh still further away but slightly larger, tail valve close to the seventh but a little larger.

India : Andaman and Nicobar Islands. Indo-Pacific.

Family MOPALIIDAE

The valves are almost concealed by the girdle. The anterior valve has eight ribs corresponding to eight ridges on the anterior margin. The insertion plates bear slits and the teeth are not pectinate. The intermediate and posterior valve bear a single slit on each side. The posterior valve has a

median sinus on the posterior side. The sculpture consists of distinct to indistinct radial and longitudinal ribs. The girdle is more or less hairy or with bristles but never with spines.

The family contains seven genera and about 50 species.

***Plaxiphora tricolor* Thiele, 1969**

(Fig. 20.1)

Animal small, 15 mm in length and 10 mm in width. First valve sculptured with eight radiating ribs, intermediate valves with distinct central and lateral areas, two radiating ridges on the lateral area, girdle very narrow and with bristles.

India : Tamil Nadu : Royapuram beach, Madras, Cape Comorin (Karya Kumari); Kerala : Varkalay.

Leloup (1937) gave detailed description of the scales.

Synonym : *Plaxiphora indica* Thiele, 1964.

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Class GASTROPODA

Subclass PROSOBRANCHIA

Shell is always present; no shell-less prosobranch has been reported from India. It is minute to large and of diverse shapes, usually spirally coiled, sometimes limpet-like, rarely tubular. Operculum is present in the majority. Head has a single pair of tentacles bearing eyes at their bases. Foot is strong with a flat sole. There is a radula in the majority. Mantle cavity and its organs are located in the anterior end near the head. It contains a pair of ctenidia, osphradia and hypobranchial glands. Some have only one ctenidium, which is always in front of the heart. Nervous system is streptoneurous with crossed cerebro-visceral connectives. The right part of the loop passes over the intestine and the left one below. Sexes are separate in majority and united in a few. Male usually has a copulatory organ.

In India, prosobranchs are known to occur mainly in marine ecosystem, a few operculates on land and a few in freshwater. It is the largest subclass with a total of about 152 families and over 20,000 species. A total of 82 families and 1000 species are reported from India.

Order ARCHAEOGASTROPODA

These are primitive forms with a spirally coiled shell in majority and patelliform shell in a few. Shell is medium to moderately large. Mantle cavity contains two bipectinate ctenidia, two osphradia, two auricles and two kidneys. The reduction of organs on the primitive left side is not complete in some. Radula is rhipidoglossate with numerous marginal teeth. Gonad does not open out directly but opens into the right kidney. These are predominantly marine inhabitants with a few species occurring in coastal freshwater streams and on land.

Of the total 37 families known worldwide, 16 families are reported in India. Of these two are nonmarine.

Family HALIOTIDAE

Ear Shells or Abalones

The name Ear Shell is due to the resemblance of the shape of shell to that of a human ear and abalone is a trade name used in shellfish markets in America and elsewhere.

Ear Shells are flattened like limpets, with a distinct and more or less excentric spire on the posterior end of the dorsal surface. Aperture is large and oval and without an operculum. Outer surface of shell is covered with a rough, horny periostracum but inner surface is pearly iridescent. Shell is well perforated with a spiral row of respiratory holes, the opened holes varying between five and ten in number, on its left margin. The holes towards apex are closed. Tentacular gill filaments protrude through each open hole through which water circulates. The last perforation

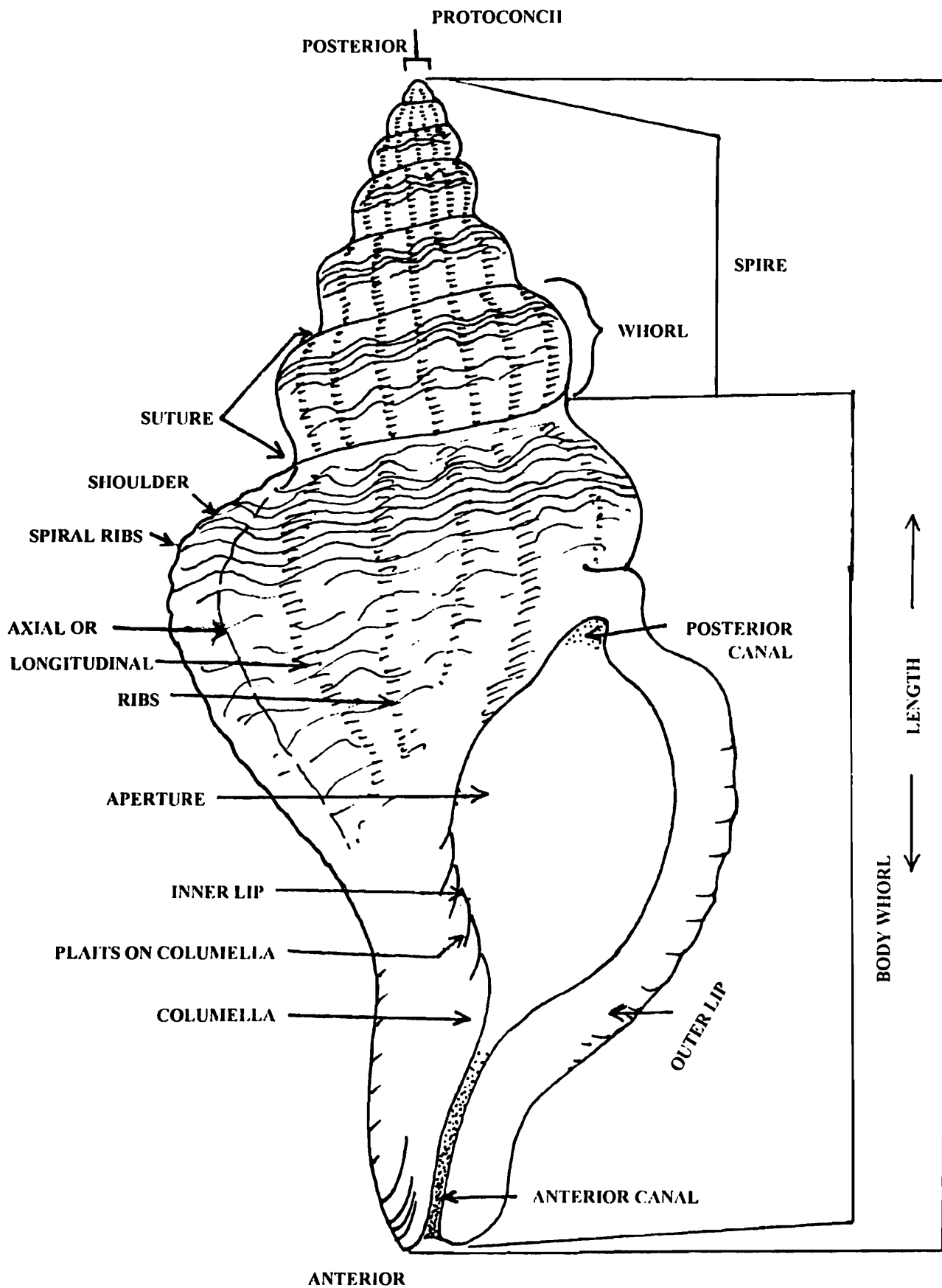


Fig. 21. Typical gastropod shell and the terminology used.

acts as an anal funnel to get rid off the wastes that accumulate inside the shell. The snail attaches to the substratum with its strong and broad muscular foot. The animal bears two long tentacles on its anterior end. Radula is of primitive type and bears numerous marginal teeth. Gills are paired.

The family is small and monogeneric. There are about 70 living species world – wide and as many as six species in Indian waters. These snails are algal grazers and occur in the littoral zone, from 0-50 m depth, in the coral reef ecosystem of Andaman and Nicobar Islands, Gulf of Mannar and Lakshadweep.

Tropical species of *Haliotis* are fewer in number and smaller in size than the temperate ones. Indian species are smaller in size compared to the temperate ones. The largest Indian Ear Shell, *Haliotis asinina* measures 7 cm in length where as the California abalone, *H. rufescens* grows to over 29 cm.

Although not eaten in India, abalones are valued highly as food in America and Japan. Foot is the edible part but often the entire viscera are eaten. In certain season swallowing viscera may be poisonous to man. Due to their lustrous mother-of-pearl layer shells were used in inlay work. Large exotic abalone shells were used in the interior of the tomb of Salim Chisti, a Muhammadan Saint, in Fatehpur Sikri, near Agra. Pearls of inferior quality are sometimes secreted by abalones.

***Haliotis asinina* Linnaeus, 1758**

(Pl. 1, fig. 1, 2)

Shell large, up to 70 mm in length, slender, long and half as wide, outer surface smooth except for growth striae and a few concentric ridges around the spire, spire slightly elevated. Four concentric ridges between the holes and left edge of the shell. Holes seven, broad, not elevated and progressively decreasing in size from the anterior end. Surface green and mottled with dark green. Shell comparatively smaller than the animal and cannot cover it completely.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Haliotis diversicolor* Reeve, 1846**

(Pl. 1, fig. 5, 6)

Shell of medium size, 30 to 50 mm in length, broad and flat. Outer surface coarse with unevenly marked ridges radiating from the spire to the lip. Eight to nine perforations open, moderately broad and not raised. Dark olive green, splashed with light green.

India : Andaman and Nicobar Islands. Indo-West Pacific.

Haliotis jacnensis Reeve, 1846

(Pl. 1, fig. 3, 4)

Shell of medium size, 30 to 48 mm in length, narrow, spire elevated. Twenty to twenty two spiral and scaly ridges arising from near the spire and terminating near the holes, two scaly ridges between the holes and left edge. Ten perforations open, closely arranged, narrow and tuberculated.

India : Andaman and Nicobar Islands.

Haliotis pulcherrima Gmelin, 1791

(Pl. 1, fig. 9, 10)

Shell small, 15 mm in length, circular-ovate. Spire elevated, ribs prominent and scabrous. Eight perforations open, of equal size and not raised. Cream colour with reddish brown markings.

India : One example bearing the locality label 'South India', which may be from the Gulf of Mannar. Elsewhere : restricted to Pacific.

Haliotis ovina Gmelin, 1791

(Pl. 1, fig. 7, 8)

Shell small to medium in size, 20 to 40 mm in length, oval. Outer surface coarse, ribs run from apex to lip, with a concentric row of nodules towards the centre, apex slightly elevated. Five to six holes open, tubular and elevated. Olive green colour.

India : Andaman and Nicobar Islands. Indo-Pacific.

Haliotis varia Gmelin, 1791

(Pl. 1, fig. 11, 12)

Shell small to medium in size, 20 to 40 mm in length, thick and broadly ovate, apex depressed or elevated. Outer surface coarse, with oblique rows of nodulose spiral cords. Perforations five or six in number, moderately broad, elevated and tubular. Colour variable, the collection contains olive green or marbled with green shells.

India : Tamil Nadu : Gulf of Mannar (Krusadai and Shingle Islands); Andaman and Nicobar Islands. Indo-Pacific.

Commonly found attached to stones or corals in coral reefs.

Synonyms : *Haliotis semistriata* Reeve

Haliotis viridis Reeve

Family FISSURELLIDAE**False Limpets, Key-hole Limpets, Slit Limpets**

These differ from True Limpets and other limpet-shaped forms in possessing either a perforation at the apex of the shell, or a slit or notch in the anterior region.

Shell is depressedly conical, round, oval or oblong ovate and generally attenuated anteriorly. External sculpture consists of radiating striations or ribs, with crenulated or smooth margin. Perforation at the apex varies in size and shape but often defined by a circumscribed and elevated callus inside. Interior is smooth and not porcelaneous. Operculum is absent.

Animal has a short snout bearing a pair of cylindrical and pointed tentacles with eyes on their outer basal portion. A large, oval and fleshy foot with fringed margin helps the animal to cling to rocks or other substrata in the sea. A pair of symmetrical gills helps in the respiration.

The family is widely distributed extending from shallow to deep sea. It is distinguished into three subfamilies on the basis of the position of the perforation, the shape of the callus margin inside and the shape of the muscle scars. All the three subfamilies, namely Fissurellinae, Emarginulinae and Diodorinae have their representatives in Indian Seas.

Subfamily FISSURELLINAE

Shell has apical perforation at or near apex. Callus margin is rounded on the inside. Muscle scars are rounded at ends.

***Lucapinella canalifera* (G. & H. Nevill, 1896)**

(Pl. 2, fig. 1, 2)

Shell small, up to 8 mm in length, thin, oblong ovate, narrow, crenulated at each end, sculptured with 15 to 16 strong, radiating ribs crossed by distinct concentric striae, apex subcentral, perforation large, callus oval inside, ribs seen as coloured bands inside.

India : Andamans. Majority of the species of the genus *Lucapinella* were reported from the Atlantic Ocean.

***Lucapinella gaylordae* Preston, 1908**

(Pl. 2, fig. 3)

Shell small, up to 10.75 mm in length, oblong ovate, laterally contracted, posteriorly somewhat elevated, surface sculptured with coarse, scaly radiate ribs and concentric grooves. Perforation almost in the centre, large, oval and contracted near both ends, rim with thick callus and crenulated

within. Margin laterally blunt, acute at the ends. Colour greenish white with irregularly arranged dark brown rays.

India : Andamans. Endemic.

Macroschisma elegans Preston, 1908

(Pl. 2, fig. 4)

Shell small, up to 10 mm in length, oblong narrow, sculptured with concentric striae and longitudinal ridges, the latter raised, about 20 in number extending from perforation to anterior margin, concentric striae thin and obsolete, the whole surface looks cancellated. Perforation long, triangular, wide end near posterior margin, a wide shallow, white channel leading from the perforation to the posterior margin. Peristome acute anteriorly, thick posteriorly and laterally. Colour light yellowish.

India : Andamans. Indian Ocean.

Subfamily EMARGINULINAE

Shell is conical or cap-shaped, apex not perforate but a slit present on the anterior margin, when with a perforation a projecting shelf within replaces apex.

Clypidina (Clypidina) notata (Linnaeus, 1758)

(Pl. 2, fig. 5, 6)

Shell small, up to 22.5 mm in length, thick, conical, sculptured with strong, dark radiating ribs, interstices between the ribs with fine radiating striae. Apex central, not recurved, margin smooth. Interior of the margin with dark coloured blotches.

India : Goa, Tamil Nadu : Gulf of Mannar (Tuticorin).

Emarginula clypea A. Adams, 1851

(Pl. 2, fig. 7)

Shell small, up to 16 mm in length, not very thick, oblong ovate, anterior end narrower than the posterior end, slightly elevated surface sculptured with evenly-spaced wavy ribs crossed by thin concentric striae giving latticed appearance, apex subcentral. Slit narrow and extends almost half the distance between apex and margin. Creamy white. Internally smooth, radial ridges seen on the interior margin giving indistinctly crenulated appearance.

India : Andamans. Elsewhere : Red Sea, Sri Lanka.

Emarginula eximia A. Adams, 1851

(Pl. 2, fig. 9)

Shell small, up to 12 mm in length, ovate, narrow, sculptured with eight widely spaced radiating ridges, interspaces between the ridges with a radiating rib and distinct concentric

striae, apex towards the posterior end. Slit small, margin crenulated and the ridges extending beyond the margin give the shell a polygonal shape. Internal surface smooth, margin sinuous.

India : Andamans.

***Emarginula fulginea* A. Adams, 1851**

(Pl. 2, fig. 8)

Shell small, up to 12 mm in length, roundly ovate, sculptured with uniformly strong, closely placed radial riblets and obsolete concentric striae, apex in the posterior half and inclined backwards. Slit very small and squarish.

India : Andamans.

***Emarginula obovata* A. Adams, 1851**

(Pl. 2, fig. 12, 13)

Shell small, up to 12.5 mm in length, sculptured with numerous strong, ornamented radial riblets crossed by concentric striae giving almost a cancellate appearance, shell margin crenulated, apex in the posterior half and slightly inclined backwards. Slit long and narrow, extends to half of the distance between the apex and the anterior margin. Shell uniformly pale brownish.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu : Gulf of Mannar.

***Rimula exquisita* A. Adams, 1851**

(Pl. 2, fig. 10a, b)

Shell small, up to 18.4 mm in length, thin, conical, apical whorls present, inclined to right, sculptured with fine radiating striae, margin lightly crenulated. Perforation on anterior slope without an internal septum.

India : Nicobars. Elsewhere : Sri Lanka.

Subfamily DIODORINAE

Shell is conical and with distinct sculpture, apex perforate, supported within by posteriorly truncated callus, muscle scar open anteriorly and with hook-shaped terminations.

***Diodora funiculata* (Reeve, 1850)**

(Pl. 3, fig. 1)

Shell small, up to 22.5 mm in length, thin, conical, anteriorly narrow, sculptured with widely spaced strong spiral ridges with weaker ribs in interspaces, crossed by fine concentric ridges. Perforation nearly rounded and towards anterior end. Exterior cream white with reddish brown rays, inner surface smooth, whitish and glossy, margin tinged and slightly wrinkled caused by external ribs, white rim around perforation inside.

India : Gujarat : Gulf of Kachchh; Kerala, Tamil Nadu : Mahabalipuram, Gulf of Mannar, Kanya Kumari. Elsewhere : Persian Gulf, Pakistan.

***Diodora induscica* (Reeve, 1850)**

(Pl. 3, fig. 2)

Shell small, up to 26 mm in length, ovate, slightly elevated, subconical, sculptured with irregular radiating ridges and crossed by concentric ridges giving an obtusely latticed appearance. Perforation oblong, slightly contracted in the middle. Greenish white with olive green rays.

India : Gujarat : Gulf of Kachchh; Tamil Nadu : Gulf of Mannar (Krusadai Island). Elsewhere : Pakistan (Karachi).

***Diodora lentiginosa* (Reeve, 1850)**

(Pl. 3, fig. 3, 4)

Shell small, up to 20 mm in length, oblong ovate, concave, rather depressed, sculptured with distinct radiating ridges crossed by raised concentric lines giving thickly latticed appearance. Perforation in the anterior third, orbicularly ovate and longer than in other species. White with irregular brown markings.

India : Andamans.

***Diodora rupellii* (Sowerby, 1834)**

(Pl. 2, fig. 11)

Shell small, up to 20 mm in length, deeply conical, thick, sculptured with stronger radial ridges and concentric ridges forming nodules at intersections, perforation towards the anterior end. Shell margin corrugated, internal rim of perforation posteriorly truncated. White with red or brown coloured rays.

India : Andamans. Elsewhere : Red Sea, Aden, Mauritius.

***Diodora singaporensis* (Reeve, 1850)**

(Pl. 3, fig. 5, 6)

Shell small, up to 10 mm in length, elongate, conical, compressed, rounded anteriorly and posteriorly, but slightly narrower anteriorly, sculptured with moderately strong radial ridges with fine riblets in the interspaces, crossed by weaker and crowded concentric ridges forming a mesh-like network. Perforation near anterior end, broader and more rounded than in other species. Exterior white with brownish rays.

India : Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar; Andhra Pradesh : Visakhapatnam; Andaman and Nicobar Islands. Indo-Pacific.

Synonym : *Diodora bombayana* (Sowerby, 1862).

***Diodora ticaonica* (Reeve, 1850)**

(Pl. 3, fig. 7, 8)

Shell small, up to 13 mm. in length, narrow and elongate, moderately elevated, apex near to the anterior margin, area anterior to the apex concave and slopes down steeply, the posterior area of the apex slopes gradually and somewhat convex, sculptured with strong, narrow, closely-set radial ribs and concentric ridges, radial ribs alternately stronger and weaker. Perforation narrow, elongate and oblong. Shell margin slightly excavated at sides in the middle, colour dull white with brown blotches.

India : Tamil Nadu : Gulf of Mannar (Krusadai Island).

***Scutus unguis* Linnaeus, 1758**

(Pl. 3, fig. 9, 10)

Shell of medium size, up to 32 mm in length, oblong, anterior region more or less truncated and wavy, depressed and shield shaped, surface without any sculpture except concentric growth striae, apex directed backwards. Without a slit, notch or perforation. Pure white outside and within.

Animal proportionately larger than the shell exposing the entire foot below, edges of the mantle reflected over the margins of the shell.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu : Gulf of Mannar (Pamban, Krusadai Island).

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Family ACMAEIDAE

True Limpets

Shell is conical and limpet shaped, oval, more or less depressed, sculptured with radiating ribs or striae, apex towards the anterior end and inclined forwards. Aperture is with a well-defined internal border. Interior is concave, saucer-like, muscle scar horseshoe or pear shaped, open in front, porcelaneous but not iridescent as in Patellidae. There is a free branchial plume on left above neck, no branchial cordon. Tentacles are long and cylindrical with eyes on the upper part of the base. Proboscis is bordered with finger-like process.

Occur attached to rocks in the intertidal region. Herbivorous.

The family includes a single genus with a few species distributed in Indian Seas. Two genera, namely *Patelloida* and *Potamacmaea* that were formerly placed under this family are now treated under a separate family Lottiidae.

***Acmaea achates* Reeve**

(Pl. 4, fig. 3)

Shell small, up to 15.5 mm in length, oval, not very thick, moderately conical, sculptured with numerous close-set radiating riblets, apex acute, towards the anterior end. Dark gray with numerous white bands, some uniformly dark brown on the rim interrupted by small white spaces.

India : Andamans. Elsewhere : Myanmar (Arakan).

Family LOTTIIDAE

Subfamily PATELLOIDINAE

True Limpets

***Patelloida saccharina* (Linnaeus, 1758)**

(Pl. 4, fig. 1, 2)

Shell of medium size, up to 42 mm in length, solid, sculptured with seven heavy, angulated radiating ribs, interspaces between the ribs either smooth or with radiating striae. Grey coloured exterior, with darker ribs. Interior white with yellowish- brown spatula bearing dark brown spots, shell margin dark coloured with white interruptions in the area of the ribs.

India : Andamans. Indo-Pacific, common in the Pacific.

Synonyms : *Patelloida stellaris* Quoy and Gaimard, 1843

Patelloida saccharinoides Habe and Kosuge, 1966

***Potamacmaea fluviatilis* (Blanford, 1868)**

(Pl. 4, fig. 4)

Shell small, up to 14.7 mm in length, oval, thin, apex anterior, sculptured with a number of radiating striae, exterior olive brown.

Radula docoglossate, with 65 transverse rows of teeth, central absent, two pairs of lateral teeth one behind the other, bearing six cusps each, three marginals on either side with 13 cusps on each.

India : West Bengal : Gangetic Delta; Andaman and Nicobar Islands. Elsewhere : Myanmar (Irawaddy Delta).

It is an estuarine form occurring in the crevices of bricks and wooden poles, and on *Avicennia* plant up to one metre height above the ground.

Family PATELLIDAE

True Limpets

Limpet shape has been developed by a few other gastropods and hence it often becomes difficult to identify specimens based on their shells. Anatomical details are necessary for ascertaining the identity of limpet-shaped shells.

Shell is simple, oval or rounded, cap or saucer-shaped without any perforation or notch. Apex is central or towards the anterior third. Shell exhibits variation in size, shape, colour and sculpture depending on the habitat of the species. Exterior surface of the shell is sculptured with radiating ribs and concentric striae. Limpets of this family are distinguished from the other families of the superfamily Patellacea, namely Acmaeidae and Lottiidae, by the absence of ctenidium and the presence of a gill cordon on either side of the animal. It may be either continuous or broken. Radula is long and narrow and in the genus *Cellana* it is four times longer than the shell.

The family is widely distributed. It is represented by about 90 species in all seas, with about five species in Indian waters. These are algal grazers and occur commonly in the intertidal zone of rocky coasts of Visakhapatnam, Tamil Nadu, Maharashtra, Gujarat, Lakshadweep, Andaman and Nicobar Islands.

The family is divided into two subfamilies, namely Patellinae and Nacellinae and can be distinguished on the basis of radula. In the former it is shorter and folded, where as in the latter it is fairly long and coiled in loops.

Subfamily PATELLINAE

It is represented by a single species in Indian seas.

Patella flexuosa Quoy and Gaimard, 1834

(Pl. 4, fig. 5-7)

Shell of medium size, up to 50 mm in length, rounded octagonal with irregular margin, almost flat, thin or solid, apex nearly central, exterior densely sculptured, scabrous or spinose, with eight or nine radial folds enclosing in between radiating scabrous ridges, all projecting at the margin. Colour dull white, or with zigzag brown markings, interior porcelaneous, more or less white, spatula dark brown.

India : Andamans. Elsewhere : Tropical Pacific, Indonesia to Tuamotu Archipelago.

Subfamily NACELLINAE

It includes two genera, namely *Cellana* and *Nacella*. The former genus, which is restricted to the Indo-Pacific, is represented by two species along Indian coasts.

***Cellana radiata radiata* (Born, 1778)**

(Pl. 4, fig. 8, 9)

Shell of medium size, up to 32 mm in length, thin, roundly ovate, anteriorly narrow, apex generally towards the anterior third; numerous narrow, approximately equally flat-topped radial riblets separated by linear grooves, and conspicuous growth striae, underlying radial folds absent. Exterior with purplish brown markings on a yellow background, often with whitish rays, interior iridescent with irregular dark brown blotches on the margin.

India : East and West Coasts (common), Andamans. Indo-West Pacific.

Balaparameswara Rao (1975, 1976, 1978) and Balaparameswara Rao and Ganapati (1967, 1971a,b, 1972, 1973) studied the biology and physiology of the species at Visakhapatnam coast.

***Cellana radiata enneagona* (Reeve, 1854)**

Although this species was reported from Andamans, no material is available with us for study. The description is taken from Powell (1973).

Shell moderately large, narrowly ovate, shell margin irregular, apex between the centre and anterior third; nine conspicuous, irregular broad folds crossed by concentric growth striae giving the surface scabrous appearance. Interior variable colour, pale creamy with dark purplish brown streaks.

India : Andamans. Indo-West Pacific.

***Cellana testudinaria* (Linnaeus, 1758)**

(Pl. 4, fig. 10, 11)

Shell larger than in other species, up to 95 mm in length, thick, broadly ovate, conical apex at anterior third. Shell almost smooth or with weak and almost obsolete radial riblets, with concentric growth striae. Exterior dark greenish brown with dark brown markings along the margin, interior bluish silvery, large elongated spatula grayish to white or yellowish brown, shell margin with continuous or broken dark brown markings.

India : Andaman and Nicobar Islands, common in rocky intertidal zone. Indo-West Pacific, Andamans to the Ryukyu Islands, North Queensland to New Caledonia.

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Family TROCHIDAE

Top Shell, Button Shell

Shell is small to large in size, conical, pyramidal or turbinate with a flat base and a distinct spire, round aperture, umbilicus narrow or completely filled with callus deposit. Interior in many iridescent. Inner and outer lips are in different planes. Operculum is thin, multispiral and with a central nucleus.

Animal is brightly coloured, head bears two tentacles and two flattened palmettes in between the tentacles, foot with a thick fold on each side bearing tendril-like processes on the epipodium, foot dorsally ridged and ventrally longitudinally divided. There is a single left ctenidium with symmetrical filaments. Radula is rhipidoglossate with a central tooth, mostly with five lateral teeth and variable number of marginals.

The snails generally occur in the intertidal zone and subtidally at a depth of a few metres. Majority of the members feed by scraping the detritus and algae from hard substrate. There are a few filter feeders, such as *Umbonium* and carnivores such as *Calliostoma*.

Based on shell characters the family is distinguished into seven subfamilies, namely Trochinae, Margaritinae, Monodontinae, Gibbulinae, Calliostomatinae, Umboniinae, and Solariinae. Another subfamily Halistylinae that however, does not have representation in India, is also recognised (Boss, 1982). The subfamily Angariinae that was included by some in this family, treated as a separate family by some, is here considered under the family Turbinidae.

Subfamily TROCHINAE

Shell is conical, with considerable size range, nodosely ornamented, base not exactly flat but excavated in the middle, aperture quadrangular. Columellar lip is straight, smooth, undulating or toothed. Outer lip is sharp.

Three genera, namely *Trochus*, *Tectus* and *Clanculus* are represented in India.

Trochus niloticus Linnaeus, 1767

(Frontis piece)

It is the commercial *Trochus* and largest of the genus. Shell large, solid and pyramidal, with 8 flat-sided whorls, fluted at the sutures, base excavated in the middle. Sculptured with concentric striae, sculpture varies with the age of the shell; juveniles with sculpture on all the whorls, medium-sized adults ornamented with granose spiral cords and full-grown adults more or less smooth except for the few apical whorls. Aperture quadrangular, umbilicus excavated, with a callus coating, columellar lip separated by a gap from outer lip and meets basal lip in a well-marked angle. Operculum dark brown, horny, thin, circular and multispiral with a central nucleus. Colour white with red brown or flame like stripes.

Radula rhipidoglossate with a central or rachidian tooth, five larger and broader laterals and numerous marginals, one ctenidium on the left.

India : Andaman and Nicobar Islands only. Elsewhere : Widely distributed in the Indo-Pacific from Andaman and Nicobar Islands to Samoa and from Lu Chu Islands in Japan to Australia.

Biology

Sexes are separate but cannot be distinguished externally. The two sexes occur in about equal proportions. Mature adult specimens generally have maximum shell diameter of 7 cm. However, maturity in the males occurs when the shells attain 6-7 cm maximum diameter. Female becomes sexually mature when it is three years old and its shell height 9 cm. Age at which the snails attain maturity may vary with the habitat or location.

From various indirect evidences, Amirthalingam (1937) inferred that breeding is continuous and that spawning probably begins in April. However, Rao (1937) observed that spawning was not confined to any well-marked season and no correlation was established with the temperature.

Trochus grows fast during the first 2-3 years (up to a size of 8-9 cm base diameter) and then it slows down. It may take about 10 years for the snail to attain shell diameter of 12 cm.

It is an herbivore with a selective deposit feeding. It feeds, mainly by scraping brown and green algae growing on rocks and coral masses. Its commonest food is *Hypnea* sp.

It is extremely slow in its movements but covers a large area during its foraging activity and in search of shelter. The younger snails are more active than the older ones. In Andaman and Nicobar Islands it occurs in scattered condition in the coral reefs and crevices and undersurfaces of rocks encrusted with brown and green algal growths in the littoral region up to 22 m depth. Sandy and muddy places are generally devoid of *Trochus*. It is abundant on open coasts exposed to rough weather but rare in protected areas. It is more abundant in the Nicobar Islands at depths up to 13 m and about 0.5 to 1.5 km from the shore. In Great Nicobar it was more abundant on the eastern side of the Galathea Bay. In Andamans large number of these shells are found on the inshore reefs. Shells from Nicobars are more flat based than those from Andamans.

Under normal conditions an individual may live for over 10 years attaining a shell diameter of about 12 cm. The growth however, is variable and depends on the availability of food and maintenance of optimum conditions in snail's habitat. The snail has the capacity to withstand unfavorable conditions such as nonavailability of food and desiccation. There are no natural enemies to *Trochus* and attacks by crabs, fish, molluscs etc. seem to be almost negligible. There were no reports of any disease of significance. The mortality was mainly due to senility.

Commercial Fishing

It is exploited on a large scale in Andaman and Nicobar Islands and New Caledonia. The latter exported about 1900 tons of shells in 1978, which constituted more than 30 per cent of the world production.

In Andamans the species is commercially exploited since 1900. From 1929 to 1939, Japanese Fishery Company had engaged professional divers for collection of shells. In the early days of fishing, shells were easily available in the shallow littoral region at depths ranging from 5 m to 10 meters. As the fishing progressed the number of shells collected had declined and the operation was extended to 15 meters and more. There was a gradual decline in the catch and in one season it had fallen from 500 tons to 40 tons (Rao, 1939). The rate of collection per diver per day had also fallen from over 20 shells in 1933 to 2.3 in 1935. During the year 1939 to 1945 commercial fishing was stopped to allow the natural beds to recover. At present the administration has identified nine zones for shell fishing operations. As per the recent statistics the annual production of *Trochus* is about 400 – 500 tons fetching Rs. 45000/- per ton (Nayar and Appukuttan, 1983). At the current market prices raw *Trochus* shells can fetch Rs. 60,000 to 65, 000 per MT.

The commercial value of shells is often reduced by certain molluscs and sponges, which either bore into the nacreous layer or create deep impressions in the periostracal and nacreous layers where they attach themselves. Rao (1937) reported the following as causing some damage to the shell.

Boring bivalves : *Lithophaga (Lithophaga) nasuta* (Philippi)
 L. (L.) lineata (Quoy and Gaimard)
 Parapholas quadrizonata Spengler
 Rocellaria sp.

Epifaunal gastropods : *Saptadanta nasika* Prashad and Rao
 Patella (Patelloidea) tara Prashad and Rao
 Vermetus (Spiroglyphus) andamanicus Prashad and Rao

Sponge : *Cliona* sp.

No parasites were recorded from *Trochus* but a commensal copepod, *Panaictis camerata* Stebbing occurs in its buccal cavity.

Commercial Use

The shell has a thick mother of pearl layer, which is used in the manufacture of pearl buttons. After grinding, entire shells are used in the preparation of table lamps, ashtrays, agarbatti stands *etc.* The mother of pearl is also used in the manufacture of ornaments like earrings, pendants, necklaces *etc.*

Conservation

Starmuehlner (1983) estimated the global demand for unprocessed *Trochus niloticus* shells to be of the order of about 6000 tons per annum. In New Caledonia shells are caught before they reach maximum diameter of 9 cm. In some countries capture of *Trochus* is restricted to sizes between 6 and 12 cm. Andaman and Nicobar Shell Fishing Rules, 1978 regulate the collection of shells. A minimum size of 9 cm diameter was fixed in the case of *Trochus niloticus*.

Trochus maculatus Linnaeus, 1758

(Pl. 5, fig. 1)

Shell of medium size, up to 50 mm in height, conical, solid and heavy, whorls concave or convexly bulging, sculptured with spiral rows of strongly nodose ribs, lower rows of nodules on each whorl stronger and more pronounced than others, base flatly concave, surface with beaded spiral ridges, umbilicate. Aperture lirate, prominently dentate on edge, columella distinctly denticulate. White or gray colour, sometimes with transpiral reddish bands, or uniformly light brown. A highly variable species.

India : Andaman and Nicobar Islands, common. Indo-Pacific, widely distributed.

Synonym : *Trochus tentorium* Gmelin, 1791

Trochus (Infundibulum) radiatus Gmelin, 1791

(Pl. 5, fig. 2)

Shell of medium size, up to 45 mm in height, conical, a little broader than high, whorls convex, surface sculptured with three regular, spiral rows of rounded tubercles, uppermost row on each whorl broader than the rest, interstices obliquely striated, base rather flat, with strong spiral ridges. Columella smooth and not denticulate. Pale yellowish colour with bright, broad, transpiral, dark reddish bands, basal surface with irregular reddish spots.

India : Gujarat : Gulf of Kachchh; Tamil Nadu : Gulf of Mannar, Palk Bay; Andaman and Nicobar Islands, common in subtidal coral reefs, feeds on algae such as *Centroceras*. Indo-Pacific.

Trochus (Infundibulum) ochroleucus Gmelin, 1791

(Pl. 5, fig. 4)

Shell of medium size, up to 42 mm in height, solid, sides slightly arched giving a round bulging shape to the shell, surface sculptured with spiral rows of granules. Columella straight, denticulate, generally with four denticles, basal part of aperture also denticulate but denticles not as strong as on the columella. Surface ornamented with broad radial reddish bands.

India : Gujarat : Gulf of Kachchh, Lakshadweep, Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, common in subtidal coral reefs but not as common as *T. radiatus*. Indian Ocean.

Synonym : *Trochus stellatus* of authors.

***Trochus (Infundibulum) pustulosus* Philippi, 1849**

(Pl. 5, fig. 3)

Shell small, 24 to 28 mm in height, narrower than in all other species of *Trochus*, taller than broad, evenly conical with straight sides, sculptured with closely arranged spiral rows of rounded nodules on the upper part, with a swollen fillet or prominent open papillae on the lower part of each whorl, base convexly flattened, its surface strongly and reticulately grained. Columella denticulate. Colour dull brick red with narrow white streaks.

India : Tamil Nadu : Gulf of Mannar, common.

***Trochus (Belangeria) scabrosus* Philippi, 1850**

(Pl. 5, fig. 8)

Shell smallest of the genus, up to, mm in height, thick, slightly broader than long, sculptured with spiral rows of coarse nodules, sutures incised, body whorl keeled at periphery. Base rounded, with concentric striae, umbilicus narrow; columella dentate; outer lip lirate inside and corrugated at base. Yellowish-brown with zigzag grayish brown flames.

India : West Coast of India, especially Gujarat. Elsewhere : Arabian Gulf. Feeds on Chaetomorpha and detritus.

***Tectus fenestratus* (Gmelin, 1791)**

(Pl. 5, fig. 5)

Shell small, up to 35 mm in height, conical, longer than broad, sculptured with coarse axial ribs on the upper part of the whorl and granulose spiral cords below, base flat, with concentric striae. Non-umbilicate, glazed small patch near columella, an arcuate spiral fold on the columella, but not as strong as in *T. pyramis*. Cream colour with an ornamentation of brown patches between axial ribs.

India : Andaman and Nicobar Islands, moderately common in intertidal reef flats. Elsewhere : Pacific, not common.

***Tectus mauritianus* (Gmelin, 1791)**

(Pl. 5, fig. 7)

Shell of medium size, up to 36 mm. in height, elongately conical, solid, broader than in *T. fenestratus*, whorls convexly sloping, sculptured with axial wrinkles and spirally arranged

squamate tubercles, base concavely flattened, with concentric ridges in the middle. Columella with a strong twisted callus, sometimes with a fold on the interior of the aperture. Colour brownish white, often variegated with faint red and green.

India : Andamans, not common. Elsewhere : Madagascar, Mauritius, Singapore.

Tectus pyramis (Born, 1778)

(Pl. 5, fig. 6)

Shell moderately large, up to 70 mm in height, solid, generally longer than broad, surface finely striated and spiral rows of nodules becoming obsolete at the base of each whorl, small, blunt nodules at the sutures becoming obsolete towards the base, base flat and spirally striated. Non-umbilicate, columella with a strongly arcuate spiral fold, aperture with 4 to 5 strong teeth. Colour dull grayish brown with axial streaks.

India : Lakshadweep, Andamans, shallow reefs. *T. pyramis* var. *noduliferus* from Andamans only. Indo-West Pacific.

In some specimens the nodules on the sutures are well developed into tubercles. These are referred to *Tectus pyramis* var. *noduliferus* Lamarck, 1822.

Clanculus clanguloides (Wood, 1856)

(Pl. 6, fig. 3)

Shell small, up to 12 mm in height, solid, globose-conical, sculptured with closely set spiral rows of beaded ridges, interstices between the ridges minutely transpirally striated, every second, third or fourth rib ornamented with white and black spots arranged in twos or threes, body whorl slightly deflected and rounded at the periphery, base convex. Aperture oblique, with a false umbilicus, columella with a broad trifold tooth, basal part of lip expanded, feebly denticulate, outer lip with a strong tooth in its upper part. Colour reddish brown, marked all over with rectangular dark spots.

India : Tamil Nadu : Gulf of Mannar (Pamban, Krusadai and Shingle Islands); Andaman and Nicobar Islands, subtidal, among weeds and rocks. Elsewhere : Central and West Pacific, not common.

Synonym : *Clanculus sagittarius*

Clanculus margaritarius Philippi, 1847

(Pl. 6, fig. 4, 5)

Shell small, up to 15 mm in height, solid, broader than long, whorls flat sided, base less convex. Colour reddish orange, every second row of spiral granules on the early whorls and every spiral row on the body whorl with third or fourth granule black.

India : Andamans, subtidal rocks, not common. Elsewhere : Pacific, not common.

Clanculus microdon A. Adams, 1851

(Pl. 6, fig. 2)

Shell smaller than in the preceding two species, up to 10 mm in height, globose, relatively depressed than in other species, whorls rounded, sculptured with beaded spiral ridges, stouter ones alternate with the thinner ones, interstices between the ridges traversed by minute oblique striae, basal part with uniformly strong spiral ridges. Umbilicus rounded and tapering below, umbilical margin toothed. Aperture large, almost rounded, margin not toothed as in other species. Colour dark brown with white spots and blotches.

India : Tamil Nadu : Gulf of Mannar (Pamban); Andaman and Nicobar Islands. Indian Ocean, not common.

It resembles *Clanculus atropurpureus* (Gould), however the colour is uniformly black and without any spots.

Subfamily UMBONIINAE

Umbonium vestiarius (Linnaeus, 1758)

(Pl. 6, fig. 1a–f)

Shell small, up to 15.5 mm in height, much smaller than the commercial Top Shell, lenticular, solid, depressed, glossy and smooth. Umbilicus filled by a large subcircular, white or dark gray callus pad. Colour of the shell highly variable, white, pink or brown with dark gray or purple markings, as many as twenty-four colour morphs can occur in a population. Operculum circular, brown and multispiral.

Sexes separate, ova and sperm released into water, fertilisation external, warmer months favourable for breeding.

Button top, unlike Trochus, is a filter feeder. Its feeding activity is seen mainly during high tide and at low tide it closes the aperture with the operculum and buries itself below the wet sand.

Button shells are gregarious and occur in abundance on the wave-beaten, seaward side of sand flats in the river mouths along east and west coasts of India. It has a preference for sandy substratum with medium sized grains.

Huge quantities of button tops are collected from the coast near the Kakinada Bay, Andhra Pradesh and Port Novo, Tamil Nadu. At Kakinada they are used in the manufacture of lime. Along Tamil Nadu these are used in the preparation of garlands, door hangings and in inlay work. The flesh is also reported to be eaten in some parts and is sold in some markets of Bombay. Its use as a food is however, limited since the flesh part is very small.

India : East and West Coasts. Indian Ocean and East Indies. The snail prefers medium grade sands. It is absent in sands mixed with mud.

Monilea (Monilea) callifera (Lamarck, 1822)

(Pl. 5, fig. 9)

Shell small, up to 15 mm in width, conical, spire elevated, sculptured with closely set, raised, beaded spiral ridges, base convex. Sculptured with beaded spiral ridges, two closely arranged coalescing with each other followed by a single spiral ridge. Aperture roundly quadrate, shining interior, ridged within. Colour creamy white with sparsely arranged brown blotches.

India : Tamil Nadu : Palk Strait; Andaman and Nicobar Islands, intertidal rocks. Indo-West Pacific.

Monilea (Monilea) masoni G. & H. Nevill, 1874

(Pl. 5, fig. 10)

Shell small, up to 15 mm in width, depressed, globosely conical, whorls six, angulated, sutures canaliculated. Sculptured with closely set acute spiral ribs, at least one spiral cord on each whorl gemmated, base convex, sculptured with closely set flat spiral cords. Umbilicus deep and bordered by a broad and raised callosity, the callosity very closely, regularly and convexly striated. Columella concave, margin very thick and callously indented. Creamy white surface and cords densely spotted and lined with greenish brown, base greenish-brown and sparsely spotted with creamy white.

India : Andamans. Elsewhere : Sri Lanka.

It resembles to some extent *Monilea belcheri* (Philippi).

Monilea (Monilea) warnefordi (G. & H. Nevill, 1874)

(Pl. 5, fig. 11)

Shell smaller than in the other species of the genus, up to 10 mm in length and 14 mm in width, flatly conoidal, whorls six, angular. Sculptured with distantly placed spiral ribs bearing a little undulating costulations and a keel at the periphery, shoulder of the body whorl with coronations separated by wide interspace, base smooth or with flat superficial ribs. Aperture quadrate, columella with a denticle and a smooth thickened callosity around the umbilicus, interior of aperture with obsolete striations. Colour brown with irregular and minute white reticulations.

India : Andamans (rare). Only type collections.

Subfamily MARGARITINAE

Shell is small to moderately large in size, thin, iridescent within, ovate conical or conical turbiniform. Outer lip is thick or thin, peristome not strongly prosocline, either interrupted or continuous, inner lip generally toothless or with a tooth.

About 16 genera, but only two genera, namely *Euchelus* and *Vaceuchelus* are so far known from Indian Seas.

Euchelus alabastrum Reeve, 1857

(Pl. 6, fig. 7)

Shell small, up to 20 mm in height, sculptured with prominent carinate ridges- three on spiral whorls and eight on body whorl, four widely spaced and the lower ones closely set, beaded and interspersed with scaly striations. Aperture ovate, interior lirate and iridescent. Colour creamy white with dark brown blotches on ridges.

India : Orissa, Tamil Nadu, Pondicherry. Elsewhere : Malaysia, Penang.

Euchelus asperus (Gmelin, 1791)

(Pl. 7, fig. 1, 2)

Shell small, up to 28 mm in height, thick, whorls inflated with elevated spire, sculptured with granular or closely beaded spiral ridges. Aperture round, columella with a strong tooth on its base, outer lip thick and the ridges extending on to its margin give toothed appearance on its external margin, interior of aperture iridescent and the ridges seen through it. Colour deep bluish gray and marked with irregular patches of dark brown. Young shells with a well-developed umbilicus, disappearing in full-grown specimens.

India : West Coast of India, Tamil Nadu : Gulf of Mannar; Andhra Pradesh, Andamans. Indo-Pacific.

Synonyms : *Euchelus indicus* A. Adams, 1854

Euchelus proximus A. Adams, 1854

Euchelus atratus (Gmelin, 1791)

(Pl. 6, fig. 8, 9)

Shell small, up to 18 mm in height, globose conic, sculptured with densely beaded spiral ribs, 12 on body whorl and 5 on the penultimate whorl, sutures deeply canaliculated. Aperture circular, umbilicate, columella with a tooth at base. Colour variable, marked by irregular, obliquely transpiral rows of purplish brown spots.

India : Tamil Nadu : Gulf of Mannar (Pamban); Andaman and Nicobar Islands, intertidal rocks. Indo-Pacific.

It resembles *E. asperus* and *E. circulatus* in general shape. It differs from the former in being reddish brown and in possessing greater number of strong spiral ridges on the whorl. It differs from *E. circulatus* in having narrower and less strongly inflated whorls and in the circular nature of rings on the spiral ribs.

***Euchelus circulatus* (Anton, 1848)**

(Pl. 7, fig. 3)

Shell small, up to 12 mm in height, ovately conical, sculptured with three prominent, elevated and distantly placed spiral ridges on the penultimate whorl and nine on the body whorl, ridges bear obliquely, transpirally elongated grains and distantly placed brownish markings alternating with white. Interstices with minute transverse granules, sutures canaliculated. Aperture semicircular, umbilicus generally deep. Columella with a denticle at base. Interior pearly white and grooved.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu : Gulf of Mannar; Andamans.

***Euchelus horridus* (Philippi, 1846)**

(Pl. 6, fig. 11)

Shell small, up to 13 mm in height, globosely conic, sculptured with three prominent, raised, granose spiral ridges. Columellar edge with a small denticle, umbilicus open, interior of aperture iridescent silvery white. Colour red with brown and white maculations.

India : Maharashtra : Bombay; Tamil Nadu : Tuticorin; Orissa : Ganjam. Indo-Pacific.

***Euchelus quadricarinatus* (Horten,)**

(Pl. 6, fig. 10)

Shell small, up to 20 mm in height, globosely conic, depressed, sculptured with three or four distinct, prominently beaded spiral ridges or lamellae on the body whorl, often these ridges may be two in number. Spire suppressed in the juveniles but elevated in adults, but not as much as in *E. asperus*. Umbilicus closed in adults. In general it resembles *E. asperus* and considered as its variety by many.

India : Gujarat : Gulf of Kachchh; Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar, Madras; Andhra Pradesh : Bheemunipatnam. Indian Ocean.

Synonym : *Euchelus tricarinatus* (Lamarck, 1822).

***Vaceuchelus angulatus* (Pease, 1868)**

(Pl. 6, fig. 6)

Shell minute, up to 5 mm in height, thick, ovate conical, whorls five, sculptured with widely spaced and keeled spiral cords, seven on the body whorl and three on the penultimate whorl, interstices crossed by strong axial ribs giving a pitted appearance, umbilicus almost closed.

Aperture circular, columella smooth, outer lip giving crenulated appearance due to the keeled spiral cords. Colour white.

India : Andamans. Elsewhere : Gulf of Arabia, Sri Lanka.

Synonyms : *Minolia subplicata* Nevill

Euchelus foveolatus (A. Adams, 1851)

Subfamily MONODONTINAE

Shell is of medium size, littoriniform or turbiniform, thick, smooth or with spiral ridges. Outer lip is strongly prosocline, columellar lip either toothless or with one or more teeth.

The subfamily is represented by three genera in the Indian Seas.

***Monodonta (Monodonta) australis* Lamarck, 1799**

(Pl. 7, fig. 4)

Shell small, up to 23 mm in height, thick, globose, spire conical, apex acute, sculptured with coarse spiral cords. Umbilicus closed, columella white with a single arcuate tooth and with a plication below that. Aperture white and lirate, outer lip thick, with a number of plications interiorly. Colour dark purple, with regularly arranged rectangular and dark brown spots separated by white interspaces.

India : Gujarat, Andaman and Nicobar Islands. Indo-West Pacific.

***Monodonta (Monodonta) labio* (Linnaeus, 1758)**

(Pl. 7, fig. 5)

Shell of medium size, up to 35 mm in height, thick, globose, spire conical, apex acute, sculptured with nodulose spiral cords, sutural spiral cords with larger nodules than others. Umbilicus closed, columella white, with a single arcuate tooth. Aperture rounded, white and lirate, outer lip thick, crenulated within. Colour dark purple, a few nodules of light gray colour.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Cantharidus interruptus* (Wood, 1856)**

(Pl. 7, fig. 8)

Shell small, up to 9 mm height, conical, higher than broad, apex pointed and straight, whorls not inflated, straight with flattened sides, sculptured with evenly spaced spiral ribs, interstices narrow and groove like, lower most ribs on each whorl stouter and more prominently raised than the rest, interstices with minute obsolete transpiral striae. Umbilicus a shallow pit.

Aperture slightly squarish, columella thick and finely ridged. Colour cream, tessellated with rusty brown patches or spots.

India : Tamil Nadu : Gulf of Mannar (Pamban); Andhra Pradesh : Visakhapatnam.

***Chrysostoma paradoxum* (Born, 1780)**

(Pl. 8, fig. 1)

Shell small, up to 20 mm in height, thick and shining, spire low, smooth, sutures shallow. Columella with callous deposit, umbilicus closed. Aperture almost round, smooth, outer lip smooth and thickened, aperture golden-orange in colour. Shell colour creamy white, reticulated with green network.

India : Nicobars, intertidal rocks. Indo-Pacific.

Subfamily : GIBBULINAE

Shell is generally small, turbiniform, surface either smooth or sculptured with spiral ribs, peristome interrupted. Columellar lip smooth or with a weak tooth, outer lip strongly prosocline.

Three genera, namely *Gibbula*, *Osilinus* and *Rubritrochus* are reported to occur in Indian seas.

***Gibbula (Gibbula) blanfordiana* G. & H. Nevill, 1869**

(Pl. 7, fig. 6, 7)

Shell minute, up to 5 mm in height, thick, conical, broader than high, sculptured with strong spiral lirae separated by broad interspaces, body whorl angulated in the middle, a little convex ventrally. Umbilicus narrow and deep, columella oblique ending in a tiny denticle, outer lip faintly denticulate on the interior. Colour pinkish white and mottled with radiating brown markings.

India : Tamil Nadu : Gulf of Mannar (Pamban); Andamans. Elsewhere : Sri Lanka.

***Gibbula (Gibbula) coeni* Preston, 1908**

(Pl. 8, fig. 2)

Shell minute, up to 3.5 mm in height, turbinately conical, whorls 5, shouldered above and flat below, sculptured with coarse spiral striae crossed by axial striae giving a cancellate appearance, sutures not well defined. Umbilicus broad and deep. Aperture subcircular, columella simple, outer lip thin and smooth. Colour yellowish gray.

India : Andamans, 13 to 18 m.

***Osilinus kotschy* (Philippi, 1849)**

(Pl. 7, fig. 9)

Shell small, up to 20 mm in height, thick, taller than broad, whorls straight sided and stepped below incised sutures, apex pointed, sculptured with nodulose spiral ribs and nodules prominent below sutures, ribs smooth around umbilicus. Aperture squarish. Umbilicus narrow and deep,

columella with callous deposit, outer lip almost straight. Colour grayish white with blackish axial streaks.

India : Gujarat : Gulf of Kachchh. Not reported from the East coast of India. Elsewhere : Persian Gulf, Gulf of Oman, Red Sea and Pakistan.

***Rubirochus pulcherrimus* (A. Adams, 1855)**

(Pl. 8, fig. 3)

Shell small, up to 13 mm in height, thick, as long as broad, whorls swollen, apex blunt, sculptured with closely-set coarse spiral ridges, prominently beaded above suture and strongly keeled on the shoulder of the body whorl, widely spaced axial folds. Umbilicus broad and deep, bounded by a strong keel. Aperture round, columella without any teeth, interior of aperture creamish white with distinct spiral lirae, outer lip not very thick and margin crenulated. Colour cream, with dark brown spots just below the shoulder of the body whorl.

India : Andamans, subtidal rocks. Elsewhere : Red Sea and Arabian Sea.

Synonym : *Gibbula declivis* (Forskal, 1775).

Subfamily CALLIOSTOMATINAE

Shell is small, conical or turbiniform, base generally flattened, sculptured with spiral beaded ribs or keels. Aperture is quadrangular, peristome discontinuous, columellar lip strongly prosocline.

The genus *Calliostoma*, known by several hundred species in the Atlantic, is represented by a few species in Indian Seas.

***Calliostoma scobinatus* (A. Adams, 1854)**

(Pl. 8, fig. 6)

Shell small, up to 16 mm in height, conical, taller than broad, whorls convex, sculptured with granular, closely set spiral ridges. Base gradually declining with 6 to 7 granular spiral ridges, the interspaces with thin granular spiral riblets. Aperture subquadrate, columella simple, outer lip compressed on the upper part, thin, colour dull brown.

India : Maharashtra : Bombay, probably endemic.

***Calliostoma speciosa* (A. Adams, 1854)**

(Pl. 8, fig. 7)

Shell small, up to 14 mm in height, conical, whorls convex, sculptured with four to five granulated spiral ridges, the upper two sutural ridges more prominent than others, the lower three or four spiral ridges enclosing a thin granulated spiral ridge between the two thick ridges,

base flat and ornamented with five strongly grained spiral ridges. Aperture subquadrate, outer lip arcuate. Colour yellowish brown with red brown blotches.

India : Andamans. Elsewhere : Australia.

Calliostoma sublaeve E. A. Smith, 1895

(Pl. 8, fig. 9)

Shell small, up to 20 mm in height, conical, as broad as high, whorls flat sided, surface smooth except for the double-spiral ridges along the suture with interspace marked by axial striae, a faint spiral riblet above the suture, base flat, with three concentric striae near the columellar region. Aperture subquadrate, columella simple with a little callus deposit, outer lip simple and thin. Creamy white.

India : Andamans, Bay of Bengal.

Calliostoma tranquebarica (Roeding, 1798)

(Fig. 22, Pl. 8, fig. 8)

Shell small, up to 16 mm in height, very conical, broader than high, whorls with straight sides and sharply pointed apex, shell smooth except for two spiral ridges just above the suture, body whorl with a strongly angulated periphery, base flat, very feebly ridged. Umbilicus closed, columella smooth, arcuate, aperture rhomboidal with pearly interior.

India : Orissa : Puri; Andhra Pradesh : Visakhapatnam; Tamil Nadu : Madras, Gulf of Mannar (Pamban); Pondicherry. Indian Ocean.

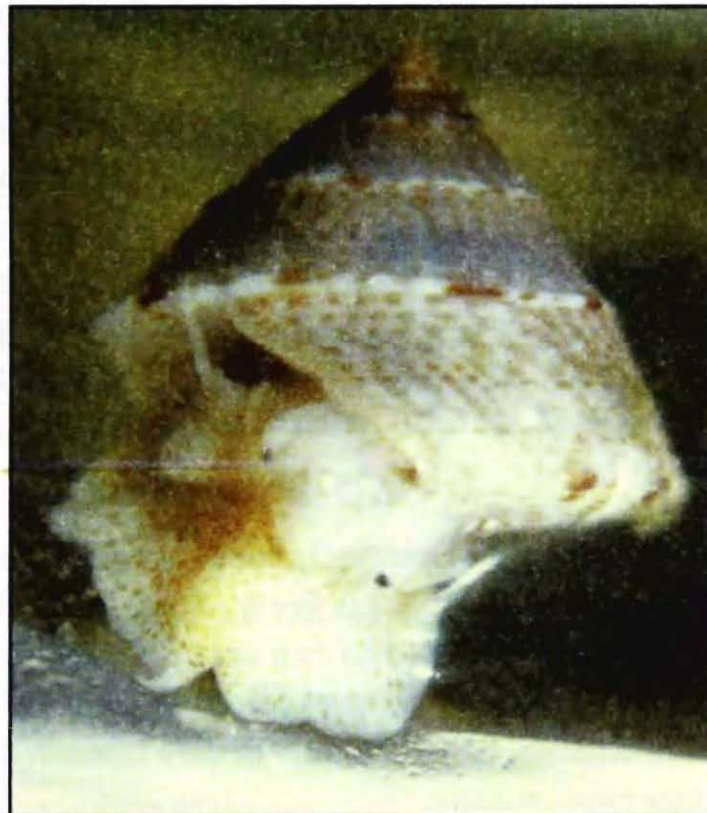


Fig. 22. *Calliostoma tranquebarica* with animal, Pondicherry.

Subfamily SOLARIELLINAE

Shell is minute to small in size, conical. Aperture is almost round, umbilicus open.

The subfamily includes three genera of which two, namely *Solariella* and *Minolia* are represented in the Indian Seas.

Solariella (Solariella) bellula Melvill and Standen,

(Pl. 8, fig. 10)

Shell minute, up to 4 mm in height, broader than high, depressedly turinate, whorls five, sculptured with spiral striae, five to six on the body whorl and two to three on the penultimate whorl, a beaded spiral cord just below the suture, spiral striae crossed by axial striae or cords, base round and traversed by three spiral striae. Umbilicus broad ornamented by axial cords, umbilical region white and surrounded by dark brown band. Aperture quadrate, columella thick, outer lip thin. Colour brownish white with dark brown blotches.

India : Orissa : Puri.

Solariella (Solariella) deliciosa Preston, 1916

(not figured)

Shell minute, up to 2 mm in height, rather depressedly conic, whorls four, carinate and angled above, body whorl with a strong keel at the periphery, the upper one tuberculated, sculptured with very minute and close-set microscopic transverse striae, sutures impressed, umbilicus moderately wide, ornamented round its margin with a broad ridge crossed by regular transverse *costulae*. Aperture diamond shaped, columella simple with a sharply curved margin outwardly expanded above into a wing like projection, outer lip acute, sharply angled at base and at the top.

India : Tamil Nadu : Ennur backwaters near Madras.

It is probably an young one of *Solariella satparaensis* Preston, 1914.

Solariella (Solariella) dulcissima Preston, 1908

(Pl. 9, fig. 1, 2)

Shell minute, up to 4 mm in height, depressedly conical, whorls $4\frac{1}{2}$, sculptured with very fine spiral striae crossed by axial striae giving a finely granular appearance, obtusely keeled, sutures impressed. Umbilicus wide, bordered by two coarse whitish ribs, the lower one being nodulose, aperture roundly ovate, columella simple, interior iridescent, with spiral striae. Colour white with large blotches of crimson, base with rows of dark crimson dashes and flecked with spots and blotches of lighter crimson colour.

India : Andamans, 13 to 18 m.

Solariella (Solaricida) infundibulum Watson,

(Pl. 8, fig. 11)

Shell small, up to 16 mm in height, not very thick, globose with elongate spire, whorls seven, rounded, sculptured with two rows of nodules on each whorl, base with indistinct axial striae and four distinct spiral ridges. Umbilicus widely open, bordered by a beaded spiral ridge, aperture quadrate, columella simple. Colour dull brown.

India : Andaman Sea, 210 m.

Minolia holdsworthana (G. & H. Nevill, 1871)

(Pl. 8, fig. 4)

Shell minute, up to 4.5 mm in height, turbate, thin, higher than broad, spire elongate, sculptured with a few distinct, widely spaced and raised spiral ribs, three on the penultimate whorl and the body whorl, the lower one running on the shoulder of the latter gives it a keeled appearance. Umbilicus open, bordered by spiral striae, aperture round and simple, columella without any callus deposit, outer lip thin and crenulated. Coloured with dark green spots and stripes.

India : Tamil Nadu : Gulf of Mannar (Pamban); Andamans. Elsewhere : Sri Lanka, Myanmar, Singapore.

Minolia casta (G. & H. Nevill, 1874)

(Pl. 8, fig. 5)

Shell minute, up to 4 mm in height, turbate, thicker than in the preceding species, whorls six, spire elevated, sculptured with distinct, closely-set spiral ribs, five on the penultimate whorl and body whorl, three on the apical whorls, sutures channeled, base gradually sloping, smooth. Umbilicus deep and narrow, bordered by two coarse spiral ribs traversed by obsolete axial striae, aperture subquadrate, columellar lip simple and straight, outer lip a little thick and smooth. Colour brownish white with dark brown blotches on the spire whorls and a dark brown spiral band on the shoulder of the body whorl.

India : Tamil Nadu : Gulf of Mannar; Andamans.

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Family STOMATELLIDAE

Shell is small, either limpet- or ear-shaped with a few whorls and a low depressed spire. Aperture is proportionately larger, obliquely elongate, without umbilicus. Operculum is present or absent.

Pseudostomatella papyracea (Gmelin, 1791)

(Pl. 9, fig. 7)

Shell minute, up to 3.5 mm in length, not very thick, whorls 3, spire short, last whorl finely spirally striate. Aperture ovately rounded, some with a narrow umbilicus and an extension of a narrow channel, operculum flat and multispiral. Surface dull brown with black markings.

India : Andamans.

Stomatella sulcifera Lamarck, 1822

(Pl. 9, fig. 5, 6)

Shell small, up to 23 mm in length, thick, narrow and elongate, body whorl large with fine spiral striae. Aperture large and oval, without umbilicus, silvery white interior, without operculum. Surface dark brown.

India : Andamans.

Stomatella asperulata A. Adams,

(Pl. 9, fig. 3)

Shell small, up to 18 mm in length, thin, spire distinct, sculptured with fine spiral striae. Aperture large and oval, without umbilicus, outer lip slightly thickened, interior dull white. Surface gray coloured.

India : Andamans.

Broderipia rosea (Broderip, 1834)

(Pl. 9, fig. 4)

Shell small, up to 23 mm in length, oval, limpet-shaped, surface smooth. Aperture large, without operculum. Surface dark brown with white coloured rays.

India : Andamans. Elsewhere : Sri Lanka.

Stomatia (Stomatia) phymotis Helbling, 1779

(Pl. 9, fig. 14)

Shell small, up to 20 mm in length, ear-shaped, thick, spire small, whorls plicate below sutures, sculptured with several spiral ribs, shoulder of the body whorl with two spiral rows of nodules, coarse and elevated axial ribs between the spiral cords. Aperture ovate triangular, without umbilicus, interior silvery white, columella smooth and concave, no operculum. Surface white in colour.

India : Andaman and Nicobar Islands, rare. Elsewhere : Japan to South West Pacific, not common.

Family CYCLOSTREMATIDAE

Shell is minute, usually not more than 3 mm in height, discoidal, often transparent, umbilicus widely open. Aperture is rounded. Operculum is round, corneous and multispiral with a central nucleus and tiny calcareous beads externally. Surface is sculptured with strong spiral ridges. Radula has a strong central flanked by numerous delicate lateral teeth.

Cyclostrema eburnea G. & H. Nevill, 1875

(Pl. 9, fig. 8–11)

Shell minute, usually not more than 2.5 mm in height, lenticular, whorls angulated, sculptured uniformly with spiral striae.

India : Orissa : Puri (Type locality). Known by types only.

Cyclostrema micans A. Adams, 1850

(Pl. 9, fig. 12, 13)

Shell minute, up to 2.5 mm in height, lenticular, whorls 4, sutures distinct, slightly raised spire, aperture round with thickened lips, a deep umbilicus. Sculptured with three raised spiral ribs crossed by axial striae, base of the body whorl with strong axial ribs.

India : Maharashtra : Bombay; Andamans.

Family TURBINIDAE

Turban Shells

Shell is small to very large in size extending up to 200 mm in height, globose, strong and solid with a few whorls and an elevated spire. Aperture is fairly large and nacreous within. Columella is smooth and arched with callous deposit. It usually is without an umbilicus. Sculpture consists of spiral ribs or ridges. Operculum is a characteristic type. It is thick, solid, flat on the inner side and convex externally. Its inner surface bears a thin, chitinous layer while the outer surface may be smooth or ornamented. It is multispiral with a central or an eccentric nucleus.

The animals resemble trochids in the possession of a pair of tentaculate processes or lappets and elongate lateral cirri. Cephalic tentacles are long. Foot is large and truncate anteriorly. Radula is rhipidoglossate with five lateral teeth. Sexes are separate. Fertilization is external and free-swimming veliger larvae are released.

Turban shells have worldwide distribution. These are common in the intertidal region and a few species occur in the sublittoral region of reef ecosystem in warm temperate and tropical seas. They feed on algae.

The family is divided into five subfamilies, namely Turbininae, Liotiinae, Angariinae, Astraeinae and Homalapomatinae, which include a total of about 500 species. The last mentioned subfamily is not reported from India.

Subfamily TURBININAE

***Turbo (Turbo) petholatus* Linnaeus, 1758**

(Pl. 10, fig. 4)

Shell large, up to 75 mm in length, longer than broad, body whorl slightly inflated, spire more or less high, totally smooth and shining except for the spiral growth striae. Aperture large and rounded, columella smooth, without umbilicus. Colour brown or brownish green, ornamented with dark chestnut spiral bands bearing white transpiral markings often of arrow-head shape, spiral bands two to three on the spire whorls and about 5 or 6 on the body whorl, surface with large irregular dark reddish-brown blotches. Aperture with silvery interior, columellar border yellowish, outer lip border white. Operculum smooth and shining with bluish green centre and brownish margins, inner face of operculum flat.

India : Tamil Nadu : Gulf of Mannar (Krusadai and Shingle Islands); Andaman and Nicobar Islands. Elsewhere : Central and Western Pacific.

***Turbo (Lunatica) marmoratus* Linnaeus, 1758**

(Pl. 10, fig. 5)

Shell largest in the family, up to 200 mm in length, solid and heavy, broader than high, body whorl very expanded and sculptured with one to three nodulose ridges and the rest of the surface smooth. Aperture large, rounded with pearly interior, columella smooth and concave, with a large, rough, wavy fasciole in adults, outer lip smooth and with a blunt knob externally, lip below the columella with a shallow siphonal canal. Surface colour green or brownish-green with spiral lines of light green or brown, often with dark brown, green or cream coloured blotches. Operculum large, heavy, smooth and white in colour.

India : Andaman and Nicobar Islands. Indo-Pacific, west of the Fiji Islands, not common.

Turban Shell has become rare in the A & N Islands and is represented by sparse populations. During the years 1994-95 and 1998-99 a total of 320 kg of shells were collected (approximately 350 numbers).

***Turbo (Lunella) cinerea* (Born, 1778)**

(Pl. 9, fig. 15)

Shell of medium size, up to 45 mm in length, thick, broader than high, spire depressed, body whorl rounded, sculptured with fine, often indistinct spiral cords crossed by fine arcuate growth striae. Aperture round, with deep umbilicus, columella with a callus deposit and produced into a pointed lobe exteriorly, outer lip sharp, aperture silvery white within. Surface colour gray, marbled with dark green often with a cream coloured band on the body whorl. Operculum finely pustulose all over, white coloured with black shade towards the labial edge.

India : Andaman and Nicobar Islands. Indo-Pacific, common.

Synonym : *Lunella porphyrites* Gmelin, 1791.

***Turbo indicus* E. A. Smith, 1894**

(Pl. 9, fig. 16-19)

Shell small, up to 23 mm in length, not very thick, spire small, sculptured with one spiral carina on the apical whorl, two on the penultimate whorl and three on the body whorl, with fine spiral striae all over. Aperture round, without umbilicus, columella with callus deposit, interior of aperture dull silvery white. Surface cream coloured. Operculum smooth, cream coloured, convex, with a depression in the centre towards the columella.

India : Tamil Nadu : Gulf of Mannar, 1093 m. Sri Lanka Endemic.

***Turbo (Marmarostoma) argyrostoma* Linnaeus, 1758**

(Pl. 10, fig. 3)

Shell large, up to 70 mm in length, longer than broad, whorls subangulate, sculptured with unequal scabrous spiral ribs and row of spines on its shoulder as well on its lower part, with axial lirae. Aperture more or less rounded, columella with or without umbilicus, interior of aperture silvery white, finely edged with green. Surface white coloured with chocolate brown streaks and green blotches on spiral ribs. Operculum white or greenish, conspicuously pustulose with striae on the margin.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific. Usually found under boulders and stones among coral reefs.

Synonym : *Turbo margaritaceus* Linnaeus, 1758.

***Turbo (Marmarostoma) bruneus* (Roeding, 1798)**

(Pl. 10, fig. 7, 8)

Shell of medium size, up to 50 mm in length, thick, slightly longer than broad, apex pointed, sculptured with uneven, raised, scabrous spiral ridges, shoulder of the body whorl keeled giving a subangular look, spiral ridges finely and transpirally grooved. Aperture moderately large, rounded, with a very narrow umbilicus, lip below columella extends downwards slightly, aperture silvery white with a pale greenish tinge. Shell cream coloured with dark brown or black and slightly wavy axial flames. Operculum finely granulate all over, dark purple on the columellar side and lighter towards the margin.

India : Maharashtra, Goa, Tamil Nadu : Gulf of Mannar (Pamban, Krusadai and Shingle Islands); Andhra Pradesh : Visakhapatnam; Andaman and Nicobar Islands. Indo-Pacific, common. Feeds on algae, *Caulerpa racemsa*, *Gracilaria* and *Centroceras*.

Synonym : *Turbo intercostalis* Menke, 1829.

***Turbo (Marmarostoma) crassus* Wood, 1828**

(Pl. 10, fig. 1, 2)

Shell large, up to 70 mm in length, thick, spire proportionately small, whorls subangulate, sculptured with spiral ridges separated by grooves, ridges crossed by longitudinal striae giving a beaded appearance, shoulder of the body whorl with a prominent carina. Aperture roundly ovate, with umbilicus, columella with sloping callus, lip below the columella produced anteriorly, outer lip thick and wavy due to ridges on the surface, aperture silvery white within. Colour creamy yellow with irregular blackish brown markings. Operculum dark brown in the centre and lighter towards margins, with granules all over.

India : Andamans. Southwest Pacific, west of Polynesia.

***Turbo (Marmarostoma) sparverius* Gmelin, 1791**

(Pl. 10, fig. 6)

Shell large, up to 80 mm in length, thick, spire elongate, sculptured with smooth, even-sized spiral cords crossed by longitudinal striae, one of the spiral cord on the shoulder of the body whorl slightly larger than others, without spiral grooves. Aperture ovate, without umbilicus, columella with white callus and produced anteriorly as a flat lobe, outer lip thick and sharp, aperture silvery white within. Colour light gray with black markings and fawn coloured interspaces. Operculum with minute granules in the centre and striae on the margin, purple brown in the centre with green margins bordered by white.

India : Andamans. Mostly Southwest Pacific, not common.

Subfamily LIOTIINAE

Shell is relatively smaller than that in the other subfamilies, surface with distinct axial and spiral sculpture, spire low. Umbilicus is present. Aperture is nacreous. Operculum is calcareous on the outer surface and chitinous within.

***Liotina cidaris* Reeve, 1843**

(Pl. 11, fig. 3, 4)

Shell small, up to 10 mm in length, thick, broader than long, spire depressed, sculptured with prominent axial ribs crossed by spiral ribs, the latter in groups of closely placed twos or threes followed by pits in the interspaces separated from other such group. Aperture rounded with small deep umbilicus bordered by a rib, surrounded by distinct pits on the top, columella with callus extending below into a distinct canal, outer lip thin supported by a varix. Colour cream. Operculum not seen.

India : Tamil Nadu, Andamans. Elsewhere : Indonesia.

***Liotina peronii* (Kiener, 1839)**

(Pl. 11, fig. 1, 2)

Shell small, up to 16 mm in length, solid, longer than broad, spire depressed, sculptured with transpiral varicose ribs giving it prominently angulated or polygonal shape, interspaces between the varices crossed by longitudinal ridges giving latticed appearance. Aperture rounded, with widely open, funnel shaped umbilicus, bordered by a rib, columella and outer lip thick. Surface cream coloured. Operculum round, concave in the centre, with minute granules.

India : Tamil Nadu : Madras; Andamans. Mostly Pacific.

Synonym : *Liotia varicosa* (Reeve, 1843) of authors.

Subfamily ANGARIINAE

Shell is moderately large, spire low, surface with rows of nodules or branching spines. Aperture is round or ovate, interior nacreous, either denticulate or striate, umbilicus wide. Operculum is horny and thin resembling that of *Trochus*.

Angaria (Angaria) delphinus (Linnaeus, 1758)

(Pl. 11, fig. 5–8)

Shell large, up to 70 mm in width, solid, broader than long, spire depressed, sculptured with irregular, coarse and squamose spiral cords with hollow spines on the shoulder row, spines curved below, two to three spiral cords below the suture, six rows of spines on the dorsal surface of the body whorl separated by scaly interspaces. Aperture rounded, with a deep umbilicus, silvery to golden colour, smooth within, columella extending below into a small shallow siphonal canal, outer lip margin wavy. Surface gray in colour.

India : Andaman and Nicobar Islands. Indo-West Pacific, westward of Fiji Islands.

Synonyms : *Angaria atrata* Reeve, 1843

Angaria laciniata (Lamarck, 1819)

Angaria (Angaria) distorta Linnaeus, 1758

(Pl. 11, fig. 9, 10)

Shell of medium size, up to 40 mm in width, solid, heavy, slightly broader than long, spire slightly elevated than in *A. delphinus*, body whorl large and of considerable width, angulated at shoulders, with blunt knobs on the shoulder and flat area from suture to shoulder, sculptured with coarse uneven spiral ridges, some with nodules. Aperture rounded, with deep wide umbilicus bordered by rough and spinous ribs, aperture white within. Surface pale pink.

India : Andamans. Elsewhere : South China Sea.

Synonym : *Angaria plicata* (Kiener, 1838).

Subfamily ASTRAEINAE

Shell is conical, longer than broad, with more or less carinate periphery, base flattened, sculptured with spiral striae and nodules or spines. Aperture is obliquely ovate, with or without umbilicus. Operculum is oval and horny.

***Astralium semicostata* (P. Fischer, 1880)**

(Pl. 12, fig. 1–3)

Shell small, up to 24 mm in length, trochiform, elevated and conical, sculptured with oblique axial nodulose cords, just above suture and on the shoulder of the body whorl with prominent nodules, base almost flattened and sculptured with 10 to 12 beaded spiral cords separated by thin grooves. Aperture obliquely ovate, without umbilicus, columella with a strong fold, operculum not seen.

India : Gujarat : Kathiawar; Maharashtra : Bombay; Lakshadweep, Tamil Nadu : Gulf of Mannar; Andamans. Indian Ocean.

***Asralium rhodostoma* (Lamarck, 1822)**

(Pl. 12, fig. 7, 8)

Shell of medium size, up to 30 mm in length, thick, longer than broad, trochiform, body whorl gradually leading to the spire whorls, sutures indistinct, sculptured with oblique axial ribs, lower part of whorl with a spiral row of hollow spines, followed by another row of erect spines. Base flattened, sculptured with uneven foliated spiral cords. Aperture oval, without umbilicus, columella with callus deposit and channelled, outer lip thick and wavy, interior of aperture white in colour. Colour uniformly white. Operculum oval shaped, white in colour, margin ridged.

India : Andamans. Indo-West Pacific.

***Astralium stellure* (Gmelin, 1791)**

(Pl. 12, fig. 4, 5)

Shell of medium size, up to 40 mm in length, trochiform, thick and solid. Sculptured with oblique spiral ribs and spiral rows of short spines, base flattened and sculptured with spiral threads. Aperture obliquely ovate, without umbilicus, outer lip with a depression at the base. Colour cream.

India : Gujarat, Maharashtra, Tamil Nadu. Elsewhere : Australia.

***Bolma girgyllus* (Reeve, 1861)**

(Pl. 10, fig. 9)

Shell small, up to 28 mm in length, turbiniform, as broad as long, sculptured with spiral rows of granules crossed by thin, wavy axial threads, lower half of each whorl carry a spiral row of hollow spines, each other spine strengthened with 5 to 6 longitudinal ribs, base not flat but

sculptured with ten rows of spiral granules separated from each other by interspaces distinguished by the presence of wavy transpiral threads. Aperture oval, without umbilicus, columella with callus deposit, bordered by strong denticles and a depression giving the impression of an umbilicus, columella channeled below, outer lip thin, interior of aperture dull white in colour. Shell cream coloured with dark brown markings. Operculum with granular surface and white in colour.

India : Andamans, 75 m. West Pacific, deep water, rare.

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- Chatroponyl, S.** 1995. Green Turbo (*Turbo marmoratus* Linnaeus) an endangered species in Thailand. Phuket Marine Biological Centre, Special Publication, No. **15** : 39-40.

Family PHASIANELLIDAE

Shell is oblong ovate, spire elevated, longer than broad, smooth or with fine spiral sculpture but not ribbed, without umbilicus, with discontinuous peristome. Operculum is smooth and glossy, calcareous with eccentric nucleus, spirally ridged on the external surface.

Phasianella nivosa Reeve, 1862

(Pl. 12, fig. 6)

Shell small, up to 20 mm in length, generally resembling that of a littorinid, whorls six, body whorl inflated, spire elevated, surface smooth, glossy and body whorl with broad spiral ribs separated by narrow grooves. Shell brown coloured, encircled by evenly spaced fine discontinuous spiral white lines alternating with brown ones. Sometimes with distinct spiral row of dark brown spots or markings immediately below the suture.

India : Tamil Nadu : Gulf of Mannar (Krusadai and Shingle Islands). Indo-West Pacific.

Family TRICOLIIDAE

Shell is small, ovate, generally smooth but often with spiral ribs. Smaller specimens are with umbilicus, columellar margin arched. Operculum is convex externally.

Tricolia indica Winckworth, 1940

(Pl. 12, fig. 9)

Shell minute, up to 5 mm in length, thin, ovate, whorls five, rapidly increasing in size, longer than broad, surface smooth, sutures distinct. Aperture oblong ovate, without umbilicus, columellar margin produced below, outer lip thin. Operculum externally convex resembling that of a turbinid, white. Colour dull brown with white flecks below the sutures, a white band on the shoulder of the body whorl.

India : Maharashtra : Bombay; Kerala : Cochin; Tamil Nadu : Madras; Orissa : Puri.

REFERENCE

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Family NERITIDAE

Shell is small to medium in size, mostly globose, thick, with a few whorls and a low spire, sutures shallow or strongly indented. Body whorl is large, rounded and inflated. Aperture is reduced to almost a D-shaped opening, its straight side bordered by the columellar edge. Umbilicus is lacking. Outer lip may be thickened and toothed inside. Columella is also toothed in many and has an extensive, flattened callus, whose surface is often tuberculated or irregularly wrinkled. Surface usually is sculptured in marine forms with spiral ribs or striae and axial growth striae. Colouration is highly variable. Operculum is generally calcareous, with an internal appendage.

Head shows a definite pattern of pigmentation. A pair of long, contractile tentacles arises from a tentacular base on the dorsal side of the head. From the outer base of each tentacle arises an eyestalk with eye at its tip. Foot is strong, but small in marine forms and enlarged in freshwater forms.

Buccal cavity consists of a long, ribbon-like radula with several rows of teeth. It is a rhipidoglossate radula ($\infty:5:1:5:\infty$). Mantle cavity consists of a bipectinate ctenidium, a ridge-like osphradium, kidney, hypobranchial gland and the terminal parts of digestive and reproductive systems. Nervous system is typically streptoneurous in the majority.

Sexes are separate. Male has a penis and a prostate gland. Male gonoduct is an open, ciliated groove. Female reproductive system is more complicated than in the male. Fertilisation is internal. Egg capsules are deposited in shallow water-filled depressions on the surface of rock or underneath rocks which afford some protection from the sun. Veligers have long planktotrophic life.

The family has a cosmopolitan distribution, but majority of the species occur in the Indo-Pacific region. These inhabit intertidal rocks, mangrove swamps and jetties. About 200 species are known worldwide. Forty-two species are reported from marine ecosystem and freshwater streams, mostly along coasts of India.

The characters of taxonomic value are as follows :

1. Shell shape, colouration and surface sculpture
2. Nature of columellar callus
3. Nature of outer lip
4. Structure of teeth in the radula

Nerita (Nerita) undata Linnaeus, 1758

(Pl. 13, fig. 1–3 and Pl. 18, fig. 2)

Shell small, up to 29 mm in height, thick and subglobose, whorls $3\frac{1}{2}$, slantingly convex, spire a little exserted. Aperture with broad and thickened columellar callus bearing promiscuous

wrinkles, columella with two teeth in the middle, outer lip thickened and expanded, outer margin slightly grooved, on the inner side with 14 to 16 faintly marked elongated teeth, first and second teeth on the posterior end broader and club-shaped. Sculptured with 30 to 35 somewhat flat slightly rounded distinct and oblique spiral ribs. Coloured ash-white, mottled and variegated with gray olive, rarely three broad black spiral bands on the body whorl, aperture yellowish-white, outer lip fringed with light gray or with sparse black specks.

India : Gujarat, Maharashtra, Goa. It is conspicuously absent from the East Coast and also Andaman and Nicobar Islands. Indo-Pacific.

It occurs in the crevices of rocks near high water mark.

Nerita (Theliostyla) albicilla Linnaeus, 1758

(Pl. 14, fig. 1–4 and Pl. 17, fig. 3)

Shell of medium size, up to 33 mm in length, very thick, somewhat obtusely triangular, whorls three, narrow and gradually expanding towards the aperture, body whorl large and expanded, spire markedly depressed, scarcely reaching the upper extremity of the outer lip, suture faintly impressed. Aperture broadly semilunar, columella with large callus deposit, with fine and profuse granulations, those on the upper half larger than those on the lower half, inner columellar margin slightly convex, with 4 to 6 fine teeth in the middle, outer lip thickened, with 18-19 fine and close-set teeth on the inner margin, the knob-shaped superior most and inferior most teeth stronger than the rest. Sculptured with close-set spiral ribs diverging fan-wise towards the expanded outer edge of the shell. Colour variable, white, orange or yellow, with densely or sparsely crowded, maculated or interrupted or irregular black bands with blotches of orange. Operculum thick, externally flat, whitish and thickly granulated, internal surface light coloured with a reddish-gray centre and white margin.

India : Gujarat, Maharashtra : Bombay; Goa, Karnataka, Tamil Nadu, Andhra Pradesh : Visakhapatnam; Orissa : Paradip; Andaman and Nicobar Islands. Indo-Pacific, common from Red Sea and South Africa to Japan and Australia, rare or absent in Polynesia.

It occurs in abundance on the rocky substrata in the shady and damp places in the lower eulittoral region, occasionally extending into sublittoral region. Egg capsules were observed from February to September.

Nerita (Theliostyla) chamaeleon Linnaeus, 1758

(Pl. 14, fig. 8, 9 and Pl. 17, fig. 4)

Shell small, up to 25 mm in height, solid and globose, whorls three, convex, spire low, but pointed, suture faintly impressed. Aperture crescentic, small, deep, columella area thick, callus traversed by irregular longitudinal ridges on the inner and outer halves with granulations in

between, columellar margin of outer lip thin and sharp, inner margin with a callosity bearing 10 to 12 distinct teeth, the first and second superior teeth knob-shaped and the inferior most tooth stronger than others. Sculptured with variable number of crenulated spiral ridges crossed by faint axial lines of growth. Coloured with blotches of black, green or yellowish-green, some times with three broad, dark-brown or dark-green spiral bands, columella dull white, outer lip fringed with black spots or with a thin black band. Operculum slightly convex, externally grayish, almost regularly and finely granular, internally brownish-red in colour.

India : Kerala, Tamil Nadu, Andhra Pradesh, West Bengal, Andaman and Nicobar Islands, common. Gulf of Aden to Australia and Melanesia.

It exhibits remarkable colour variation.

Nerita (Theliostyla) oryzarum Recluz, 1841

(Pl. 14, fig. 10–13 and Pl. 17, fig. 6)

Shell small, up to 28 mm in height, globose or obliquely oval, rather solid, whorls 3 ½ to 4, spire obtuse, but slightly exserted. Aperture with not much expanded but sloping columellar callus, granular in the middle and wrinkled in the upper half, columellar margin concave, with three distinct teeth, outer lip thickened, inner side with 12 to 14 teeth, the superior two teeth knob-shaped, broader than the rest, the first tooth separated by a gap from the rest, other teeth longitudinally expanded. Sculptured with rather weak, small, and smooth spiral riblets numbering 30 to 35; riblets alternately strong and weak, often two weaker ones after a strong one, riblets more numerous and crowded on the base of the body whorl. Usually slate coloured and peculiarly mottled with zigzag maculations and sometimes an interrupted band of white, aperture white. Operculum externally ash-gray with white nuclear spot and numerous broadly rounded granules, those near the outer margin smaller and closer, internal surface flesh-red, slightly grooved on the inner margin and furrowed in the middle, apophyses strongly curved downwards.

India : Endemic to Maharashtra on the West Coast.

It occurs on rocks and stones between half and full tide marks.

Nerita (Theliostyla) patula Recluz, 1841

(Pl. 13, fig. 4, 5 and Pl. 18, fig. 3)

Shell small, up to 18 mm in height, obliquely semi-oval, a little triangular, whorls two, spire minute, impressed, apex distinct but not pointed. Aperture broadly expanded, columella flatly excavated, columellar callus moderately large, with numerous small and black granules in the middle, with an oblique fold-like structure on the posterior side, columellar margin concave and toothless, margin of outer lip not much thickened, anteriorly slightly expanded to form a fold, inside with 19 to 20 black and longitudinally elongated teeth of equal size. Sculptured with

moderately flat, 30 to 40 uneven oblique ribs with narrow interspaces. Colour uniformly light black with a mixture of pale yellow in the middle, outer lip white and fringed with light yellowish gray. Operculum externally convex with numerous granules, ash-gray with whitish nucleus, internally pale-yellow.

India : Andamans. Mainly Pacific, from Indonesia to the Philippines.

Occurs on small stones in bays with much less wave action.

Nerita (Theliostyla) planospira Anton, 1839

(Pl. 15, fig. 3, 4 and Pl. 17, fig. 9)

Shell of medium size, up to 31 mm in height, angularly semiglobose, flattened above with an obtuse shoulder angle, whorls three, narrow, compressed at the spire, broadly expanded at the aperture, spire very small, flatly impressed, sutures not distinct. Aperture with even columellar callus, granulated at the upper half and just below it a shallow depression bearing granules, columellar margin with four broad based and unequal projecting teeth, a ridge-like elevation in between the superior-most tooth and the posterior part of outer lip; outer lip thickened and broadly effused, slightly wavy in outline, inner side smooth with very faint indications of teeth. Sculptured with 20 to 25 elevated, rounded and somewhat broader spiral ribs alternating frequently with narrow, thread-like riblets. Colour yellowish-gray with maculations or zigzag striations of brownish-black, aperture yellowish-white, columellar callus yellowish-white with a long blotch of black on its upper half, outer lip fringed with black and an yellowish-white interior. Operculum flat, smooth, purplish, white near the nucleus, internal surface flesh-red; whitish, and pointed anterior end, yellowish and broader posterior end, the parietal margin somewhat tucked in to accommodate the large columellar teeth.

India : Andaman and Nicobar Islands. Mainly Pacific.

It occurs adhering to roots and stems of coastal mangrove plants like *Rhizophora* sp. one or two feet above the substratum. Not reported from the mainland India.

Nerita (Theliostyla) squamulata Le Guillou, 1841

(Pl. 14, fig. 5–7 and Pl. 17, fig. 5)

Shell small, up to 29 mm in height, suborbicular, broadly depressed, spire obtusely flattened, only slightly raised above the level of the body whorl, whorls three, broadly expanded towards the aperture. Aperture broadly effused, columella concave bearing three to four minute but distinct teeth in the middle, columellar surface concavely depressed, irregularly ridged on the outer edge and finely tuberculated in the middle, outer lip outer margin thin, inner margin thickened with 15 to 17 elongate and wide spaced teeth, the first two superior teeth broader and longer than the rest. Sculptured with irregular and crowded spiral ribs, generally 12 to 14 well

developed broad ribs enclosing in between weak and obsolete ribs, surface beset with short scaly processes giving the shell scabrous appearance. Colour variable, black or opaque white with obliquely wave-sprinkled minute gray dots or orange yellow clouded with black, aperture white, outer lip margin fringed uniformly black or with dots of black. Operculum slightly convex, externally brownish with a pink tinge, finely granular, internally yellowish-white, peg merely an elevated portion with concentric ridges.

India : Tamil Nadu, Andaman and Nicobar Islands. Elsewhere : Singapore to Japan.

It occurs in abundance near mangroves, crawling on muddy substratum. It is also found in bays and jetties but very rarely adhering to rocks. It occupies a different ecological niche avoiding mixing with the related *Nerita chamaeleon*. The mantle is brownish gray with prominent black wavy lines in *N. chamaeleon* but dull white with black wavy lines in *N. squamulata*. The sculpture on the shell and the shape of the aperture are also distinct in the two species. *N. chamaeleon* occurs on rocks in the eulittoral zone and near the low water mark. *N. squamulata* breeds from October to November.

***Nerita (Theliostyla) textilis* Gmelin, 1791**

(Pl. 15, fig. 7, 8 and Pl. 17, fig. 2)

Shell of medium size, up to 36 mm in height, ovately globose, thick, whorls three, gradually expanding towards the aperture, spire flat. Aperture slightly thickened within and ridged, columellar area flatly excavated, callus granular throughout, columellar margin concave with two faintly marked teeth, outer margin of outer lip thickened, fimbriated, strengthened by ribs, inner margin with 15 to 20 teeth. Sculptured with strong, rounded, rugose or somewhat nodose spiral ribs, alternately broad and narrow, rather irregular. Coloured white and rather distantly tessellated with black, apex and columellar callus tinged with yellow, aperture yellowish. Operculum thick and even, thickly granulated, ash-gray with white nuclear area, internally reddish-gray, the rib short and white, the peg broad and pointed.

India : West Coast, especially Gujarat. East Coast of Africa to West Coast of India.

It occurs on rocks near high water mark.

***Nerita (Ritena) costata* Gmelin, 1791**

(Fig. 23, Pl. 16, fig. 1, 2 and Pl. 17, fig. 2)

Shell of medium size, up to 32 mm in height, globose and solid, whorls $2\frac{1}{2}$, spire obtusely flattened, but with distinct conical apex, sutures indistinct. Aperture crescentic, small compared to the size of the shell, columellar area convex, columellar callus dips steeply inwards towards the aperture, surface wrinkled with ribs continuing on to the callus, columellar margin with four strong and broad teeth, the central two more prominent than the one on either side, outer lip

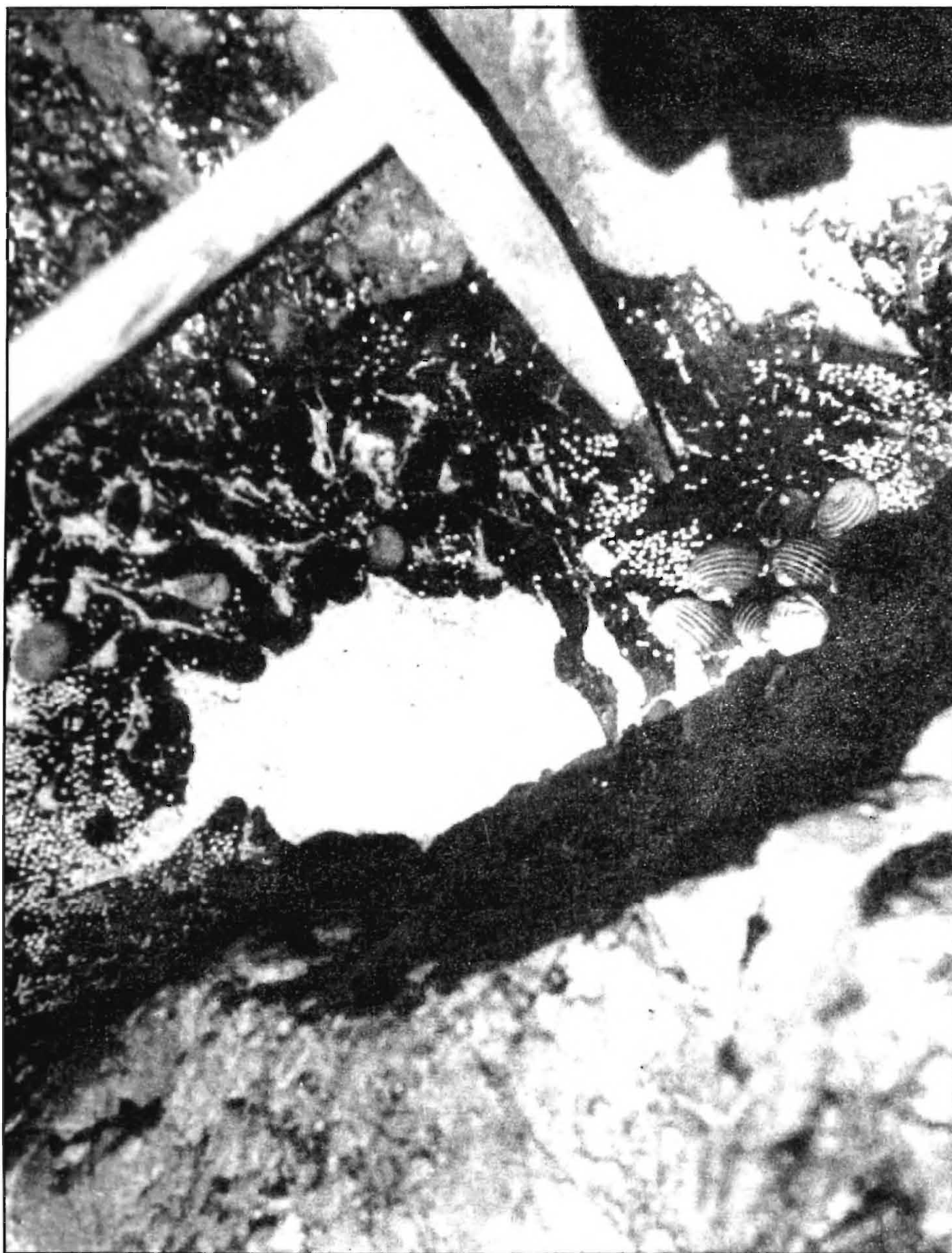


Fig. 23. *Nerita Costata* with egg capsules – Chidiyatapu, South Andaman.

thickened, slopes gradually inside, with seven strong teeth, the knob-shaped first upper tooth stouter and stronger than the rest. Sculptured with 12 to 16 regular, strong, round, broad and conspicuously black spiral ribs with very thin axial striae, interstices neatly excavated and yellow. Columellar area white often with an yellowish tinge on the callus, inner side of outer lip glistening white. Operculum somewhat thin, concave, externally gray, rib strong and curved, with striations, peg reduced.

India : Lakshadweep, not common; Andaman and Nicobar Islands, common. It usually does not occur on the mainland India, a small population noticed at Visakhapatnam was probably a recent introduction. Mainly Pacific, Australia to Japan.

It occurs in the crevices of rocks in the upper littoral zone particularly at Mean High-water springs. It is abundant on rocks along the seaward shoreline where these are directly exposed to waves and less common or even absent in sheltered bays and lagoon shores. The snails breed from September to November.

***Nerita (Ritena) grayana* Recluz, 1843**

(Pl. 15, fig. 1, 2 and Pl. 18, fig. 5)

Shell of medium size, up to 39 mm in height, ovately globose and thick, whorls $3\frac{1}{2}$, rather narrow, spire short but distinct and elevated, apex white and pointed. Aperture proportionately larger, columellar callus slopes deeply inwards, with strong wrinkles - uninterrupted in the upper half but shorter and scanty set in lower half-columellar margin concave with two to four strong and blunt teeth, a ridge-like elevation on the posterior side, outer lip moderately thickened, with a callosity on the interior bearing 19 to 20 small teeth, the first superior (posterior most) knob-shaped and the rest longitudinally elongated and moderately weak. Sculptured with strong, exalted and crenulated spiral ribs, numbering 24 to 30, on the upper half of the whorl strong ribs enclose thin ribs between them, interspaces broader than the ribs. Colour grayish black flecked with white, apex white, aperture light yellow, outer lip tessellated and flecked with black. Operculum flat, thickly granulated, gray with white nucleus, internal surface also grayish, rib strongly developed and furrowed.

India : Andaman and Nicobar Islands. Elsewhere : The Philippines.

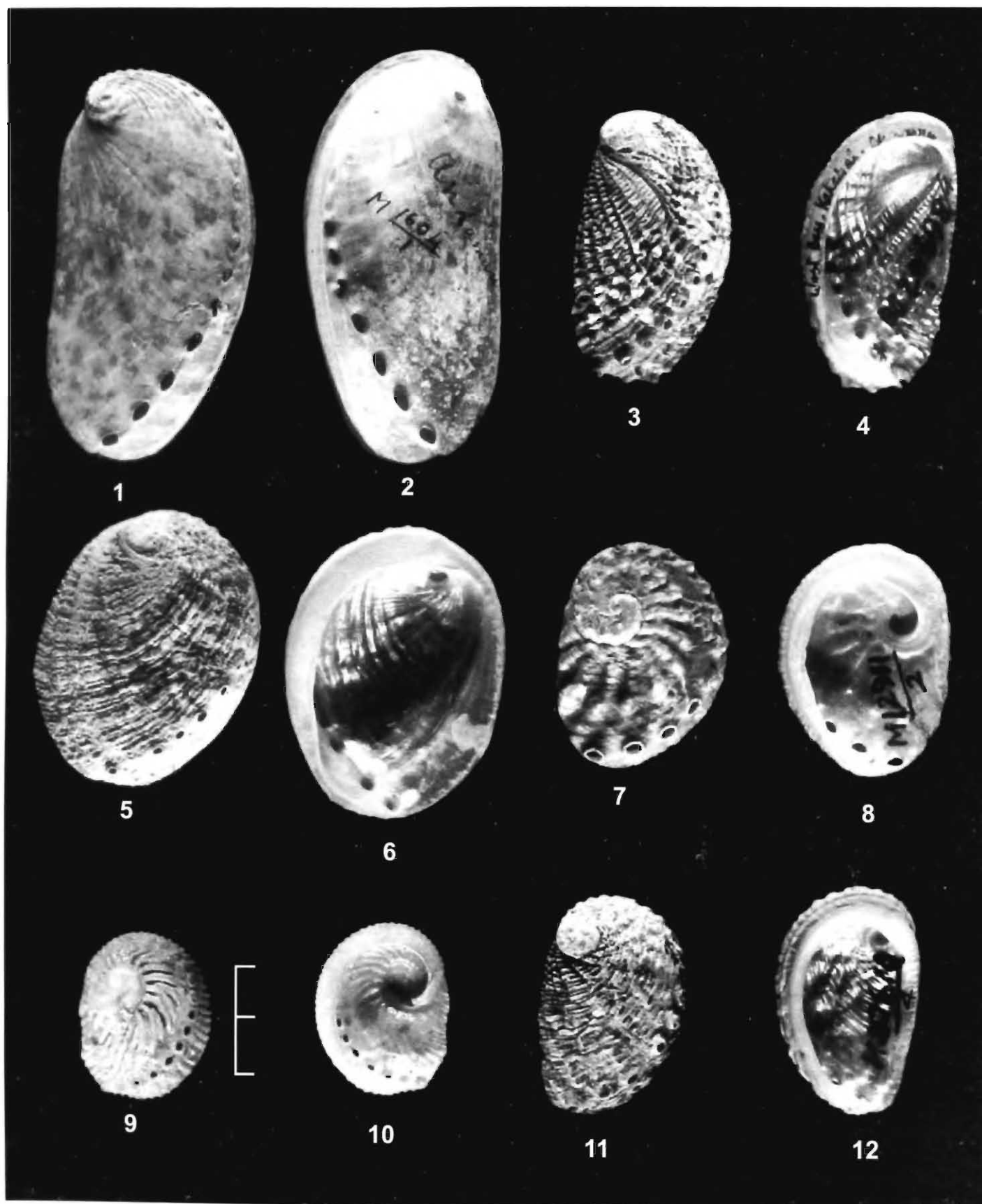
It occurs on the roots and branches of mangroves along with *Nerita planospira* and was observed to thrive well out of water even during high tide.

***Nerita (Ritena) maxima* Linnaeus, 1791**

(Pl. 15, fig. 5, 6 and Pl. 18, fig. 1)

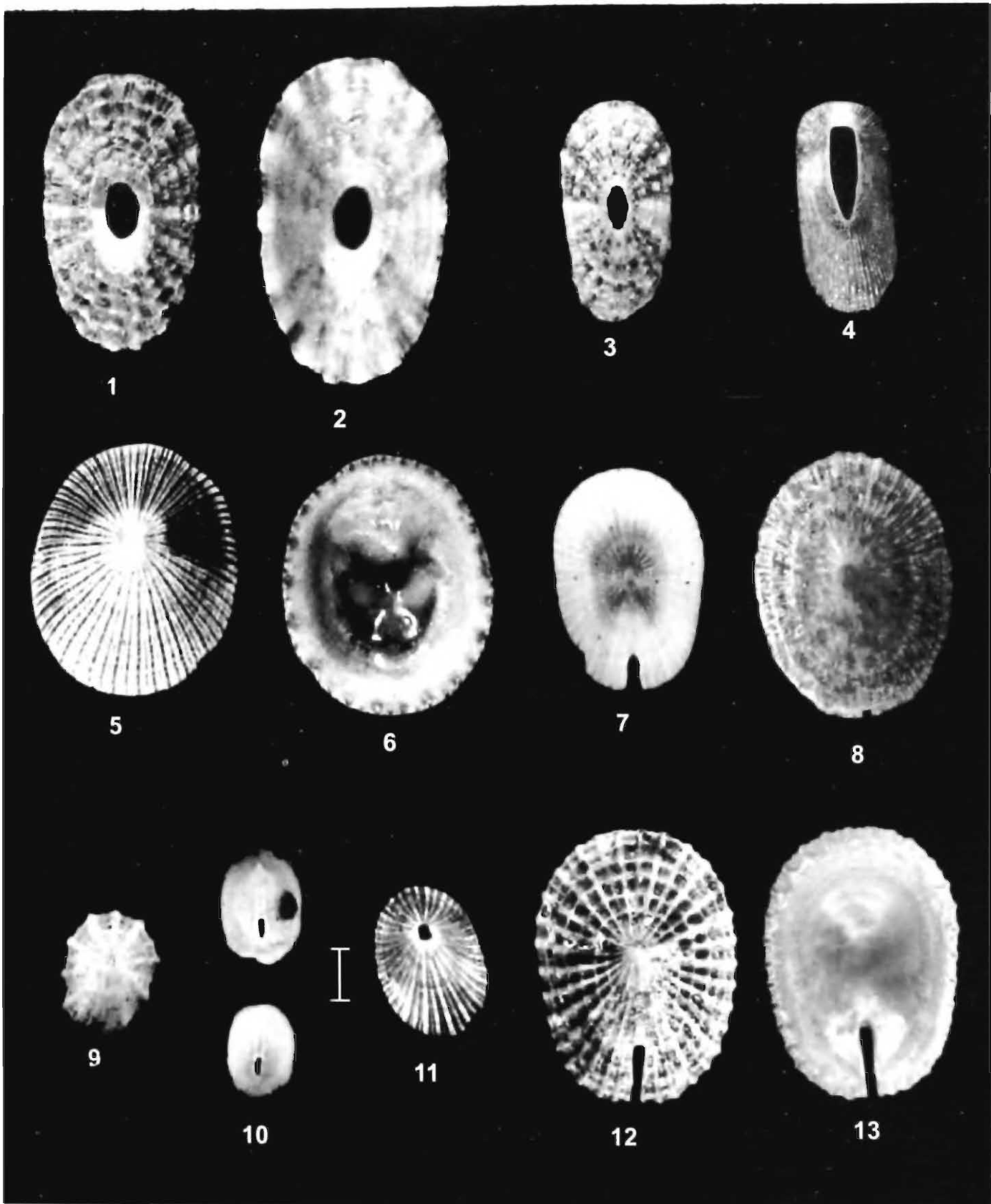
Shell largest among Indian neritids, up to 41 mm in height, obliquely oval, thick, solid, three to four times higher than broad, whorls $3\frac{1}{2}$, narrow, body whorl large and somewhat compressed

Plate 1 : Haliotidae



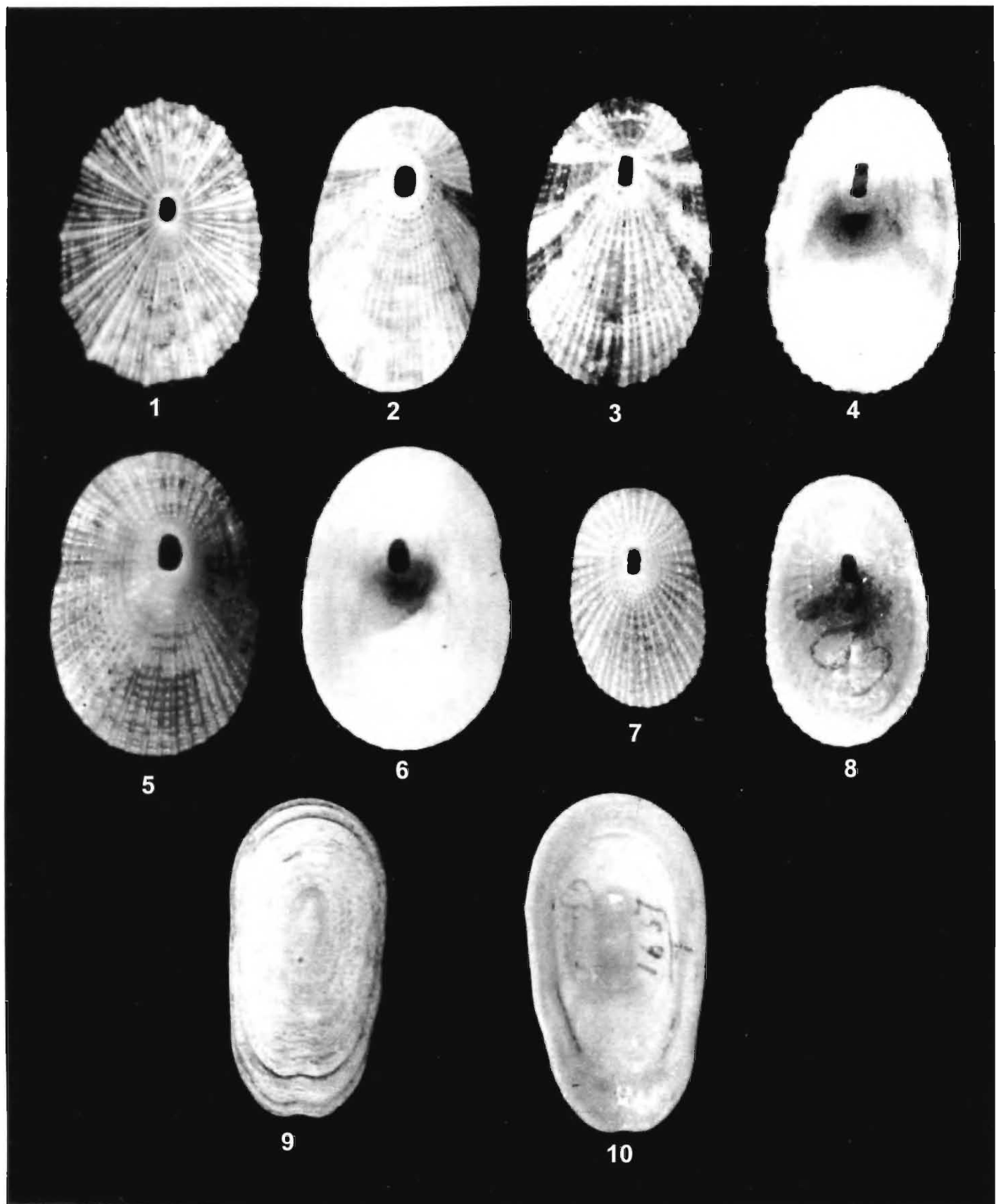
1, 2. *Haliotis asinina* : Andamans; 3, 4 *H. jacknensis* : Andamans; 5, 6. *H. diversicolor* : Andamans; 7, 8. *H. ovina* : Andamans; 9,10. *Haliotis pulcherrima* : M1633/1, South India; 11,12. *H. varia* : Gulf of Mannar.

Plate 2 : Fissurellidae



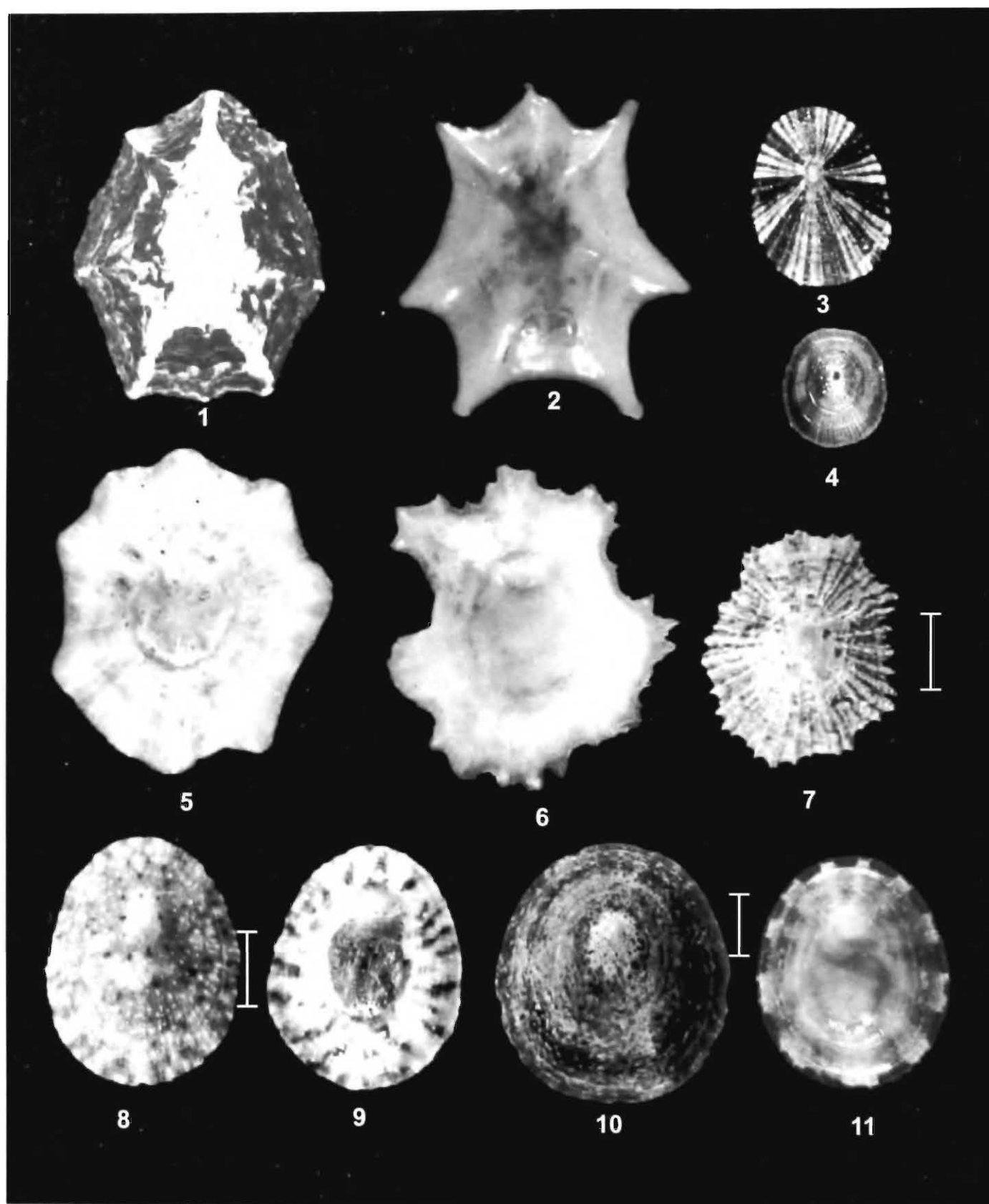
1,2. *Lucapinella canalifera* : M1651/1, Andamans; 3. *Lucapinella gaylordae*; 4. *Macrochisma elegans*; 5,6. *Clypidina notata* : Talpoma & Palaule beach, Goa ; 7. *Emarginula clypea* : Andamans. 8. *Emarginula fulginea* : M1801/1, Andamans; 9. *Emarginula eximia* : Andamans; 10 a,b. *Rimula exquisita* : Nicobars; 11. *Diodora rueppelli* : Sri Lanka; 12,13. *Emarginula obovata* : M22356/4, Visakhapatnam.

Plate 3 : Fissurellidae



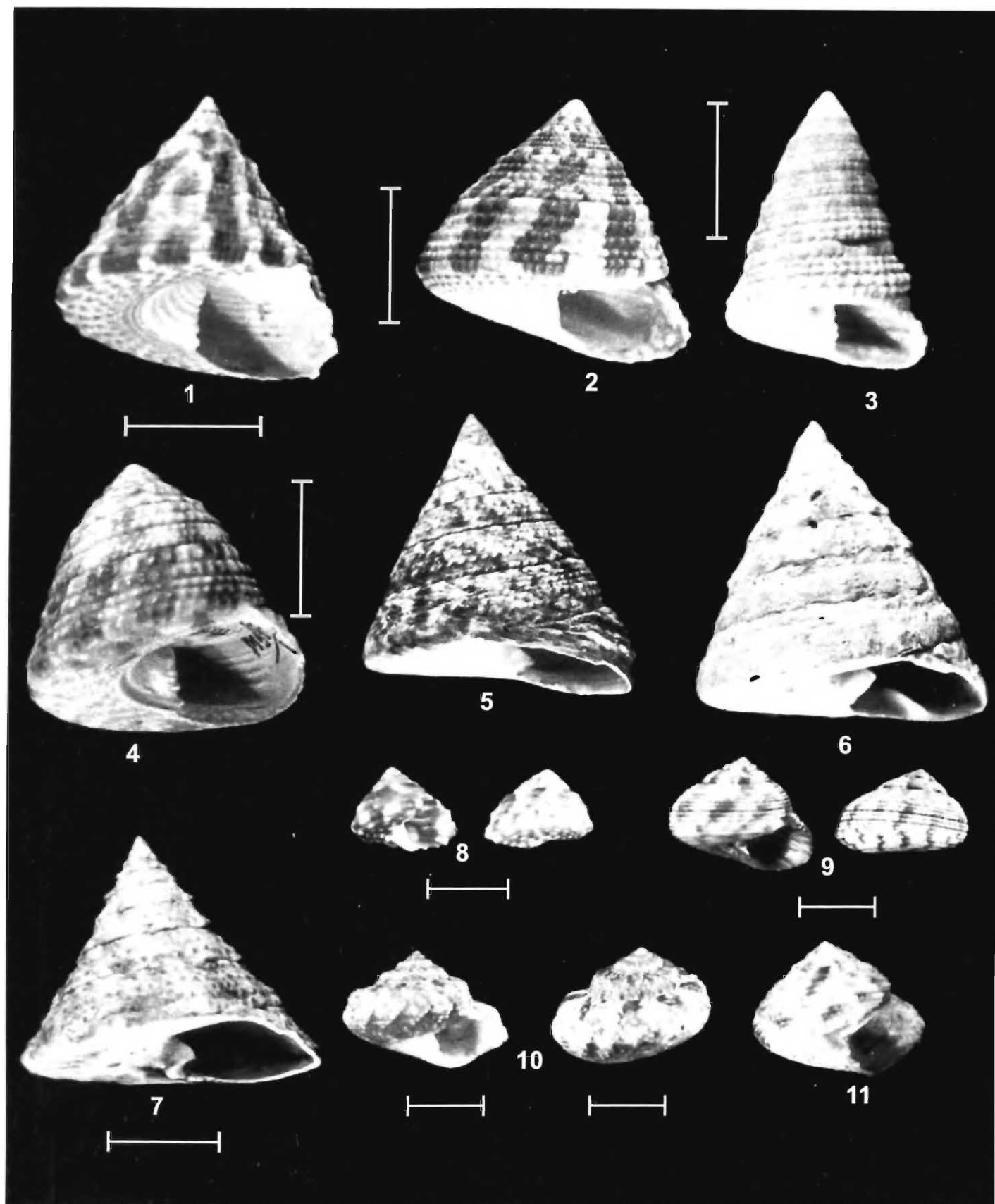
1. *Diodora funiculata* : M1719/1, Gulf of Kachchh; 2. *Diodora indusica* : M1704/1, Gulf of Kachchh; 3,4. *Diodora lentiginosa* : M1684/1, Andamans; 5, 6. *D. singaporensis* : M21409/4, 21412/4, Marmagao Bay, Goa; 7,8. *Diodora ticaonica* : Andamans; 9,10. *Scutus unguis* : M1637/1, Mumbai.

Plate 4 : Patellidae, Acmaeidae



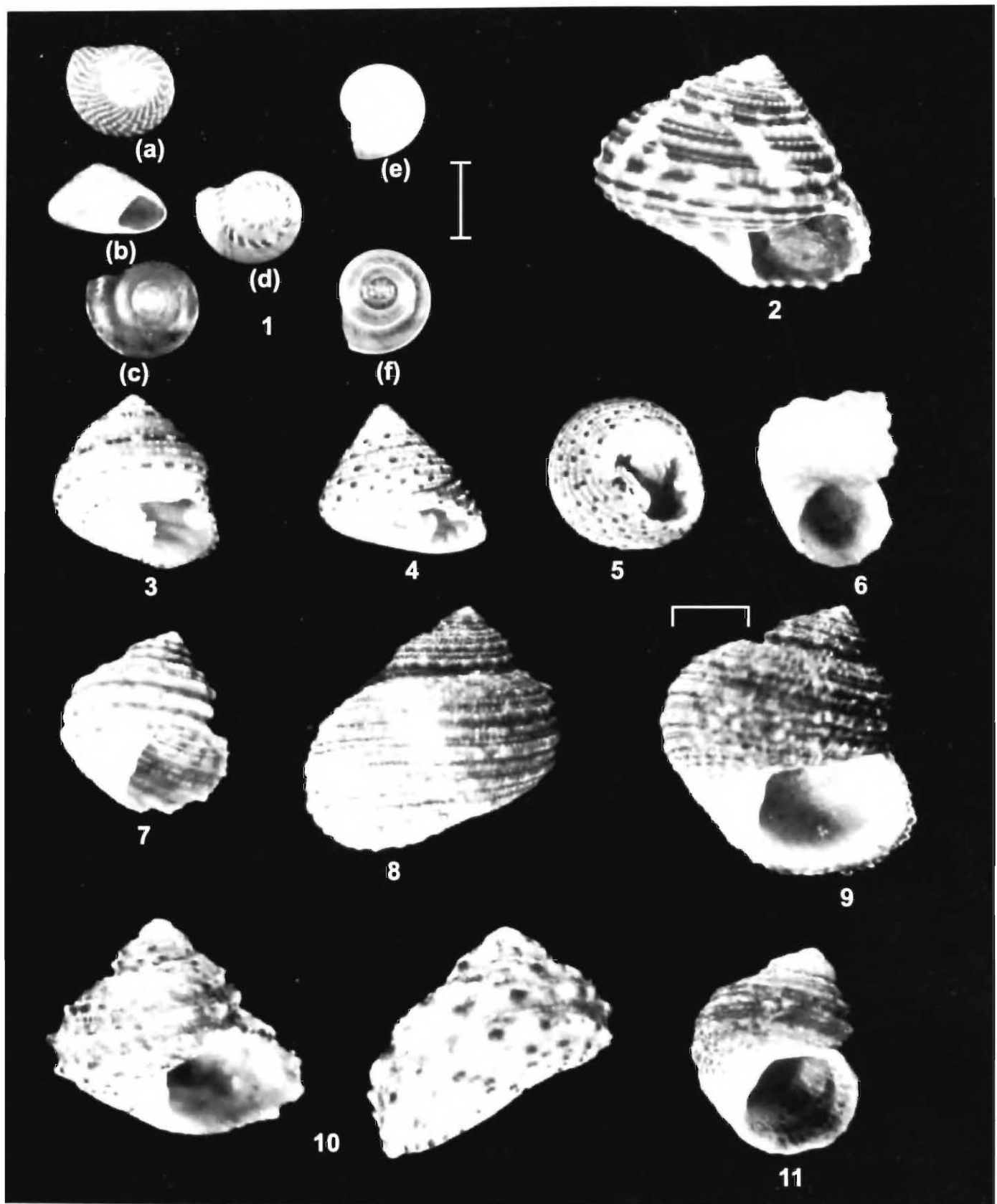
1,2. *Patelloida saccharina* : M12870/2; 3. *Acmaea achates*; 4. *Potamacmaea fluviatilis* : Sunderbans; 5-7. *Patella flexuosa* : M1830/1; 8,9. *Cellana radiata radiata* : M22543/2, Gopalpur, Orissa; 10,11. *Cellana testudinaria* : M1917/1, Andamans.

Plate 5 : Trochidae



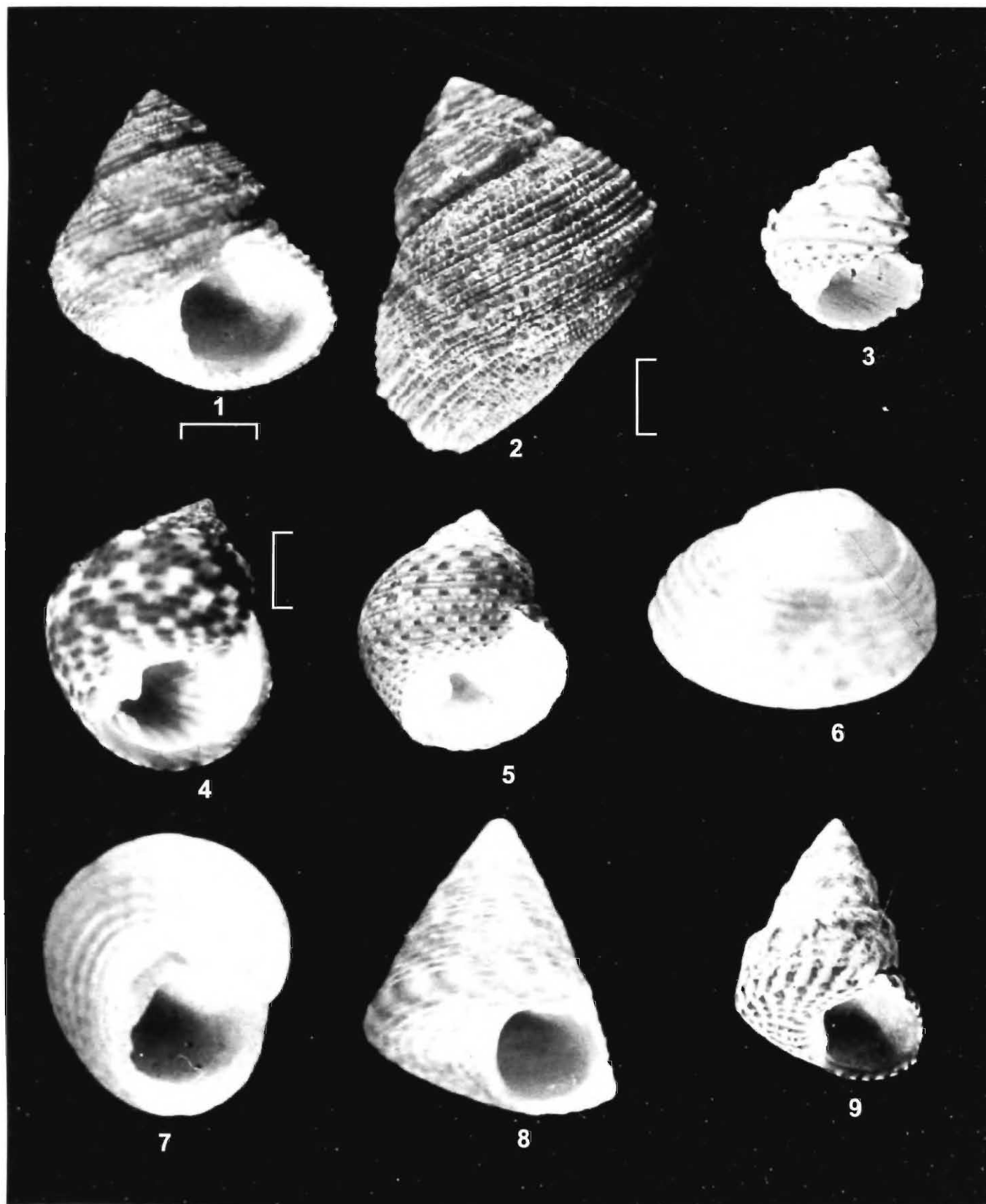
1. *Trochus maculatus* : Andamans; 2. *Trochus radiatus* : M21517/4, Vanthivu Island, Gulf of Mannar
 3. *Trochus pustulosus* : M21163/4; 4. *T. ochroleucus* : M5375/1, Andamans; 5. *Tectus fenestratus*;
 6. *Tectus pyramis*; 7. *Tectus mauritianus*; 8. *Trochus scabrosus*; 9. *Monilea callifera*; 10. *Monilea masoni*; 11. *Monilea warnefordi*.

Plate 6 : Trochidae



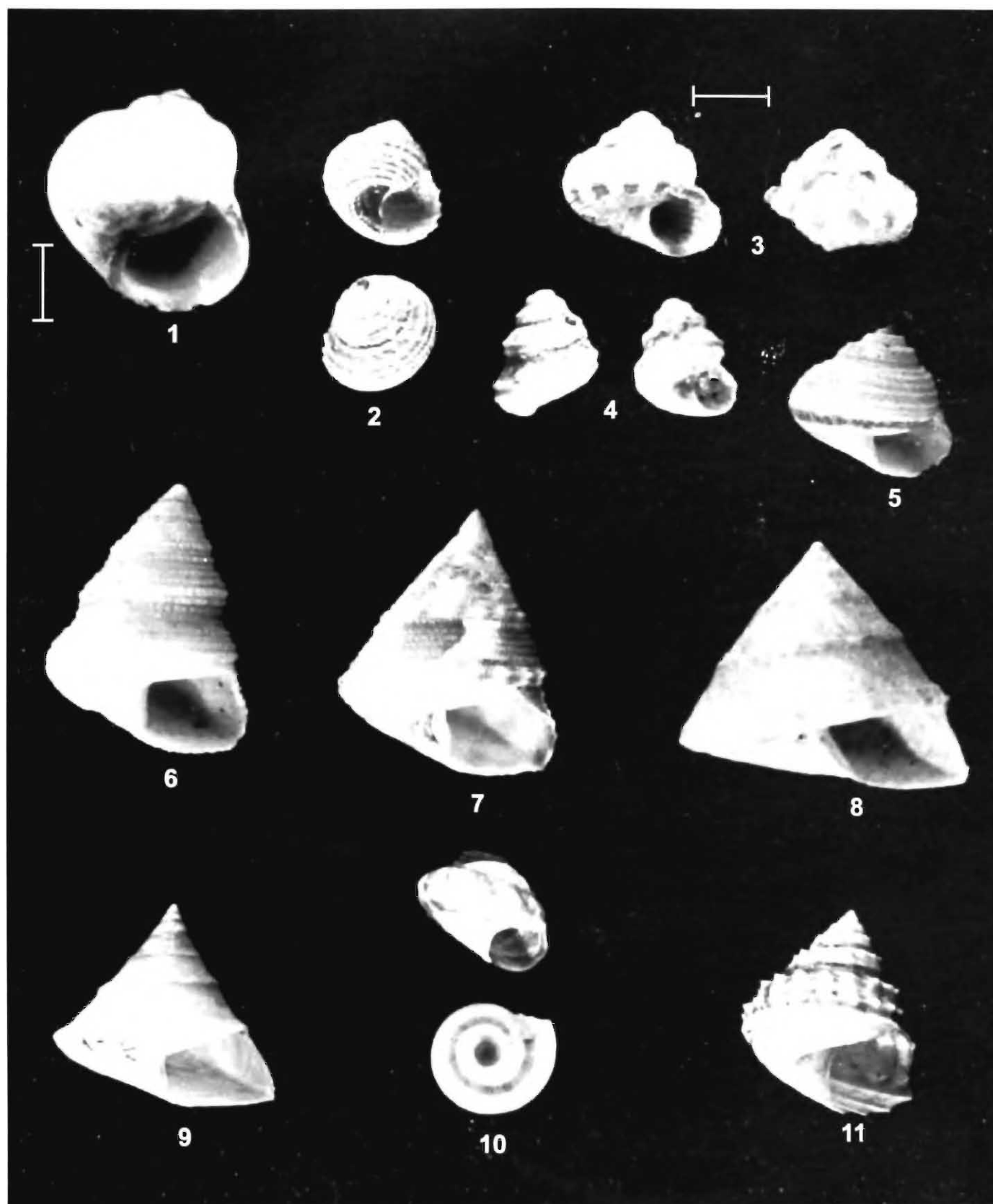
1 a-f. *Umbonium vestiarius*; 2. *Clanculus microdon* : Andamans; 3. *Clanculus clanguloides*; 4,5. *Clanculus margaritaceus*; 6. *Vaceuchelus angulatus* : x6; 7. *Euchelus alabastrum*; 8,9. *Euchelus atratus*; 10. *Euchelus quadricarinatus* : M21098/4; 11. *Euchelus horridus* : Hare Island, Gulf of Mannar.

Plate 7 : Trochidae



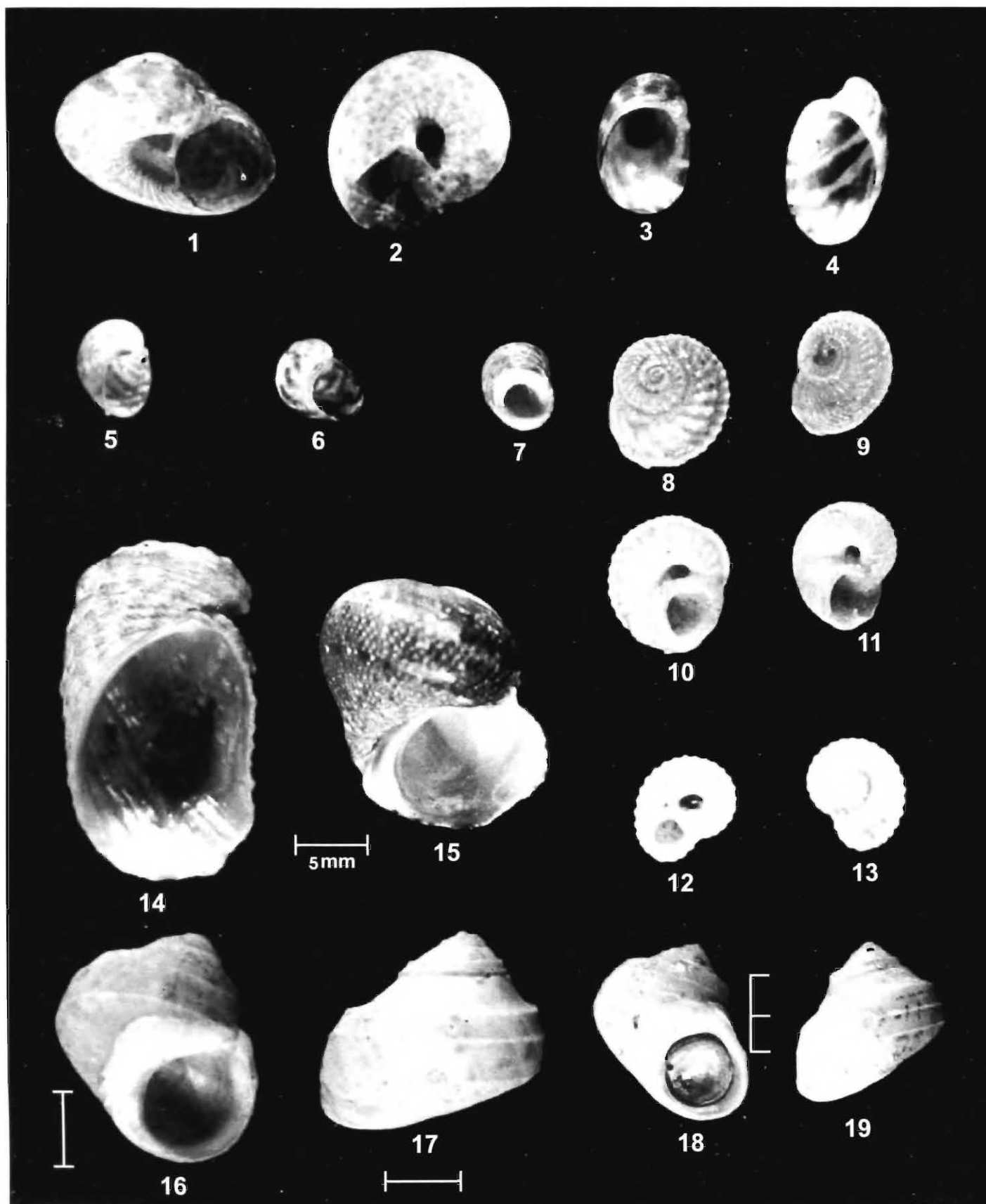
1, 2. *Euchelus asperus* : Anguina beach, Goa; 3. *Euchelus circulatus*; 4. *Monodonta australis* : M13156/2, Andamans; 5. *Monodonta labio* : Andamans; 6,7. *Gibbula blanfordiana* : M22138/4, Krusadai Island, Gulf of Mannar; 8. *Cantharidus interruptus* : M21231/4, Rameswaram, Tamil Nadu; 9. *Osilinus kotschy* : Gujarat.

Plate 8 : Trochidae



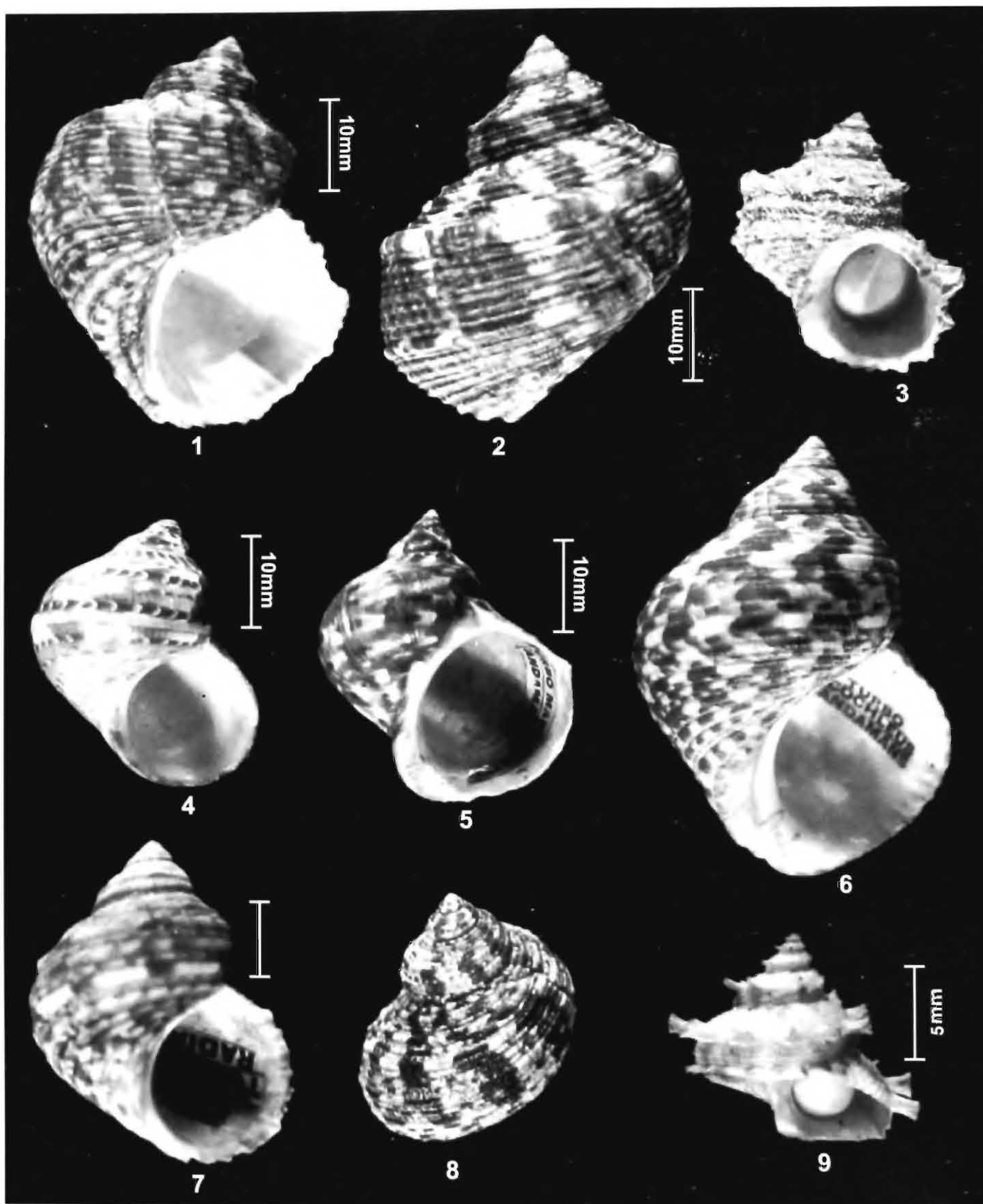
1. *Chrysostoma paradoxum*; 2. *Gibbula coeni*; 3. *Rubritrochus pulcherrimus* : M2673/1, Andamans; 4. *Minolia holdsworthana*; 5. *Minolia casta* : M21096/4, Tuticorin, Tamil Nadu; 6. *Calliostoma scobinata*; 7. *Calliostoma speciosa*; 8. *Calliostoma tranquebarica* : Tranquebar; 9. *Calliostoma sublaeve* : 193/1; 10. *Solariella bellula* : Puri; 11. *Solariella infundibulum* : Andamans, 185 fms.

Plate 9 : Trochidae, Turbinidae, Stomatiidae



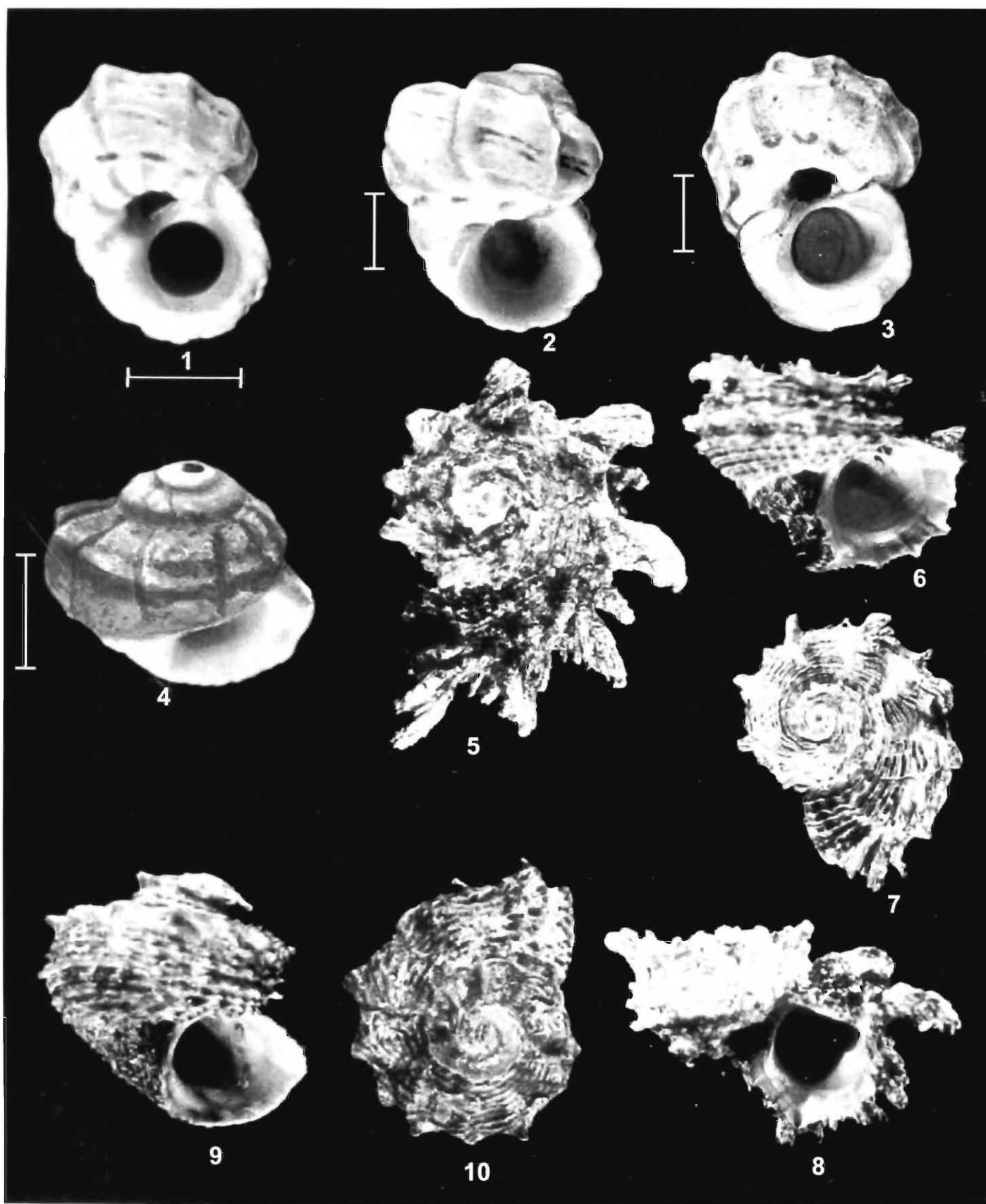
1,2. *Solariella dulcissima*; 3. *Stomatella asperulata* : M3391/1; 4. *Broderipia rosea*; 5,6. *Stomatella sulcifera*; 7. *Pseudostomatella papyracea* : M3407/1; 8-11. *Cyclostrema eburnea* : M2751/1, Syntypes, scale bar 5mm; 12,13. *Cyclostrema micans*; 14. *Stomatia phymotis* : Andamans; 15. *Turbo cinerea*; 16,17. *Turbo indica* : Gulf of Mannar, 597 fms.; 18,19. *Turbo indica*-Holotype.

Plate 10 : Turbinidae



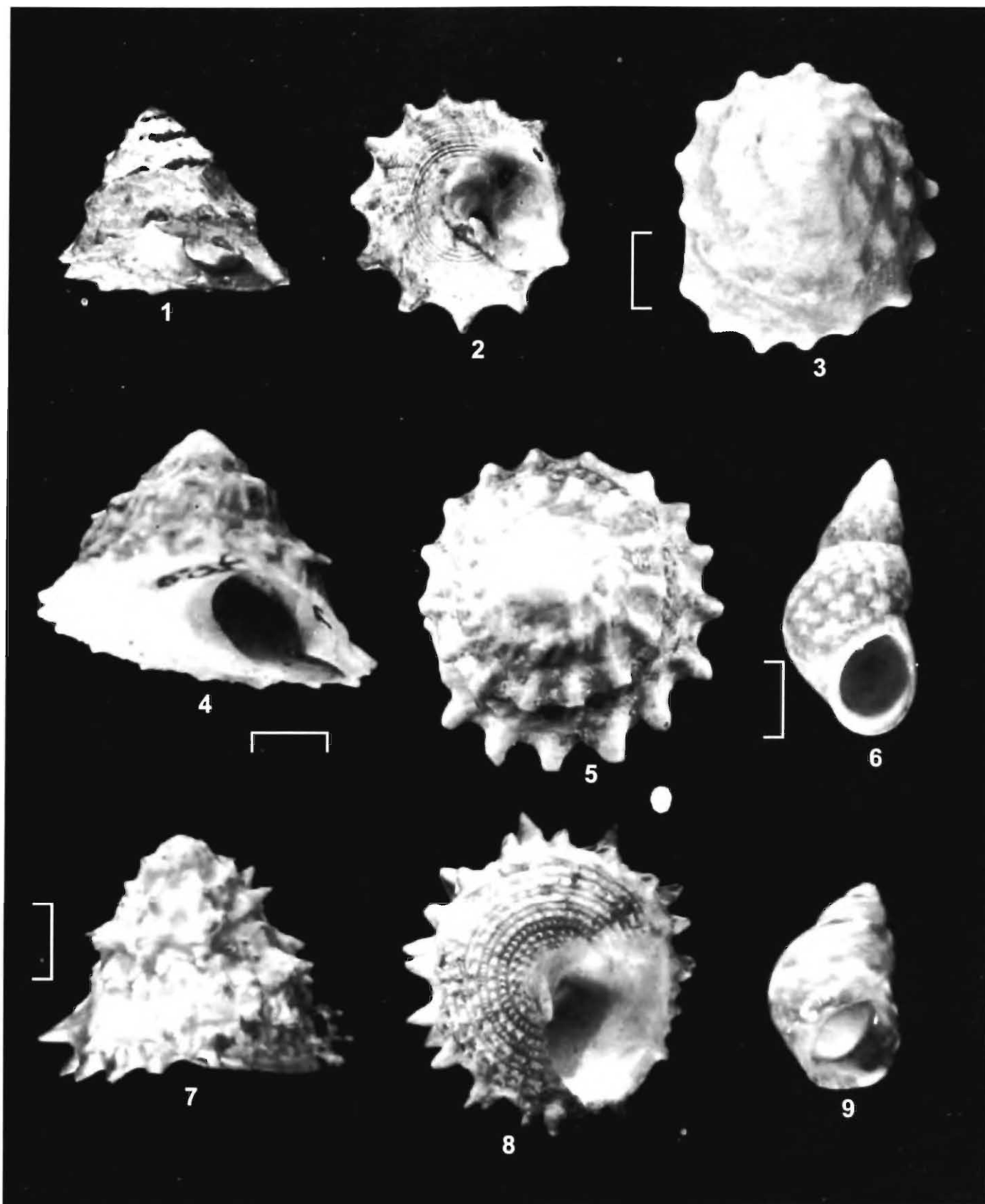
1,2. *Turbo crassus*; 3. *Turbo argyrostoma* : Andamans; 4. *Turbo petholatus* : Andamans; 5. *Turbo marmoratus* : M21418/4, Andamans; 6. *Turbo sparverius* : Andamans; 7,8. *Turbo brunneus* : Andamans; 9. *Bolma girgyllus* : M3002/1, off Andamans.

Plate 11 : Turbinidae



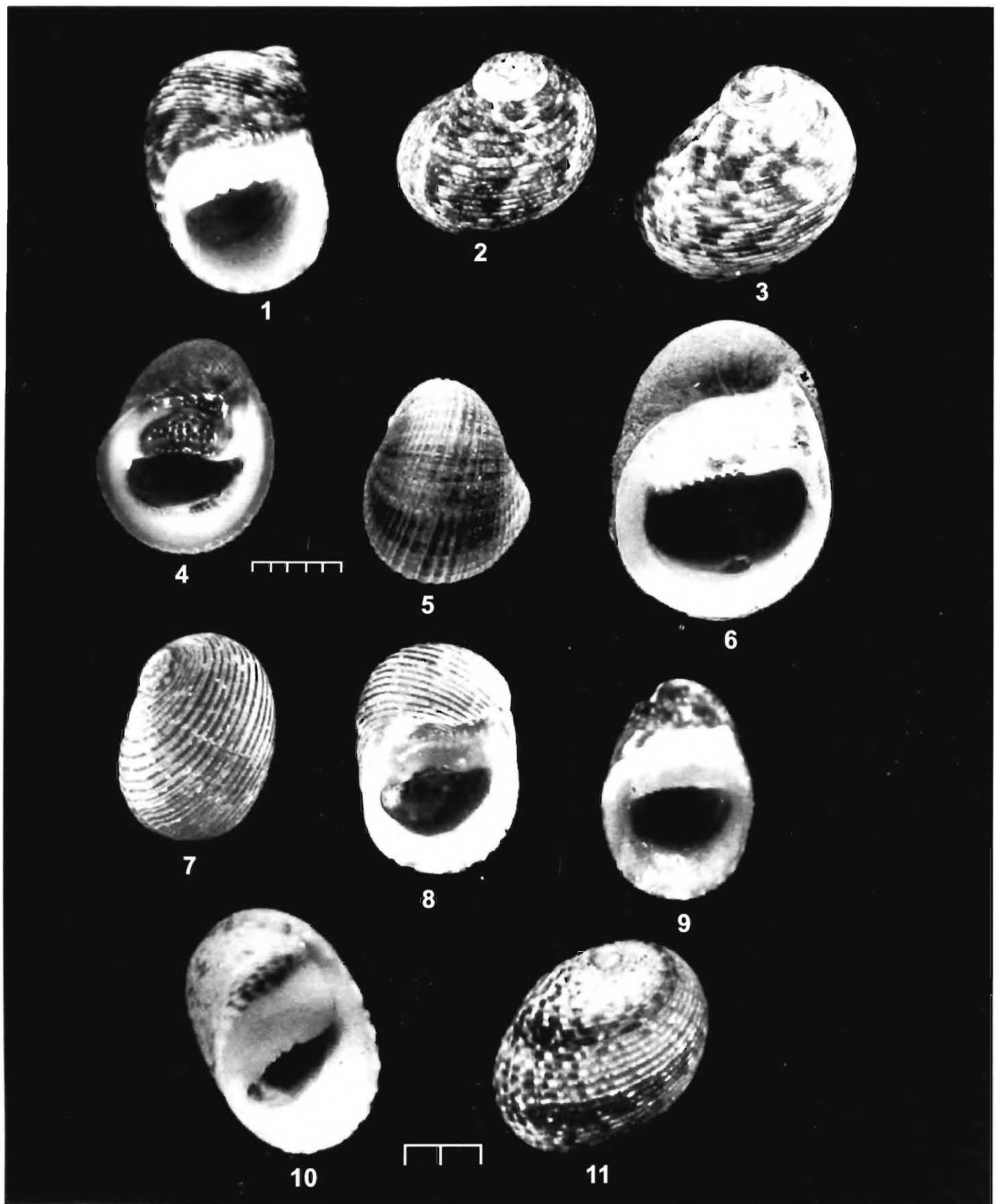
1,2. *Liotina peroni* : M20426/3, Pulli Island, Gulf of Mannar; 3,4. *Liotina cidaris* : Sri Lanka;
5-8. *Angaria delphinus* : M13059/2, Andamans; 9,10. *Angaria distorta* : M13054/2, Sri Lanka.

Plate 12 : Turbinidae, Phasianellidae, Tricoliidae



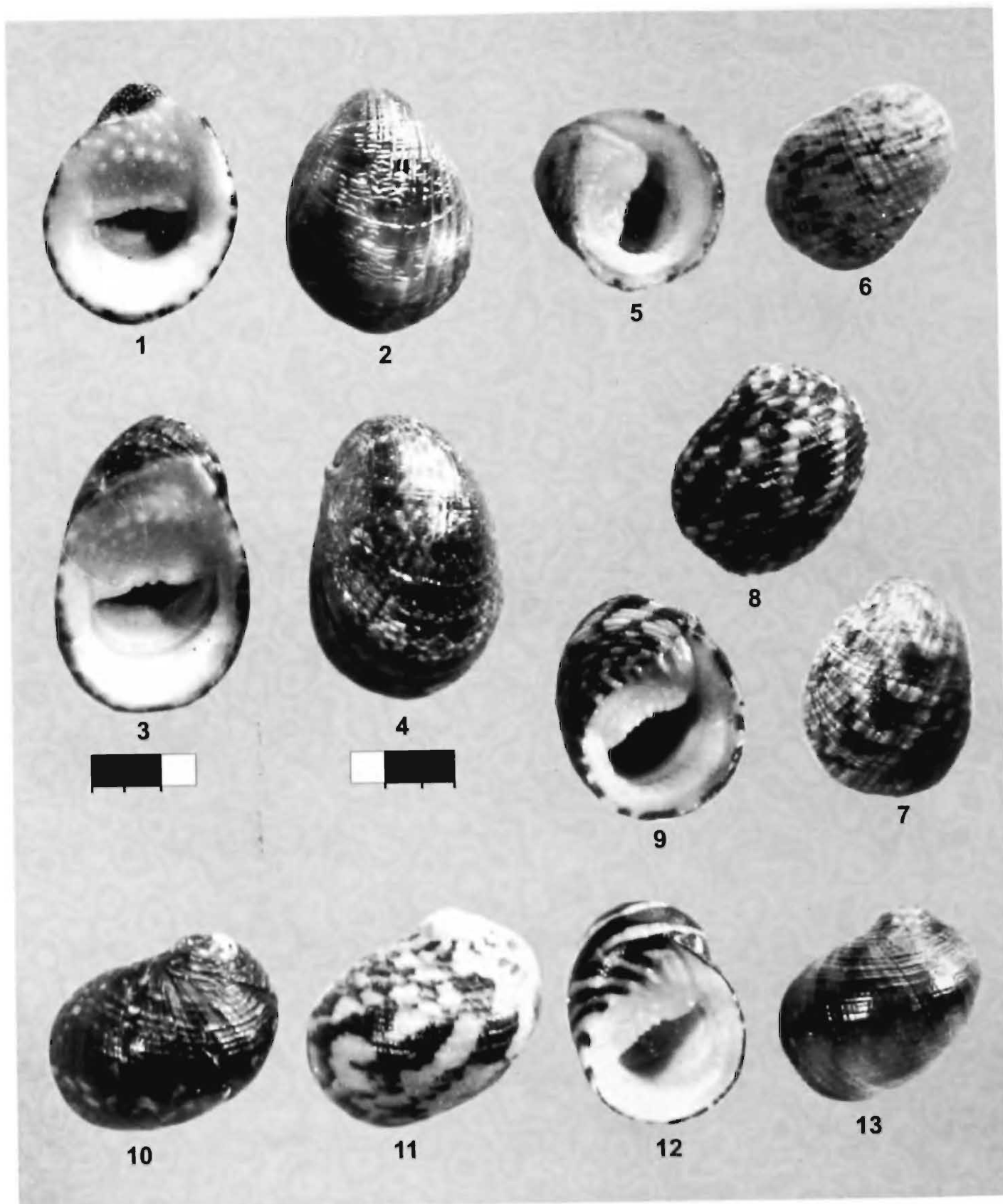
1-3. *Astralium semicostata* : M22140/4, Hare Island, Gulf of Mannar; 4,5. *Astralium stellare* : M21109/4, Vanthivu Id., Gulf of Mannar; 6. *Phasianella nivosa* : M21850/4, Rameswaram; 7,8. *Astralium rhodostoma* : Andamans; 9. *Tricolia indica*, Chengalput district, Tamil Nadu.

Plate 13 : Neritidae



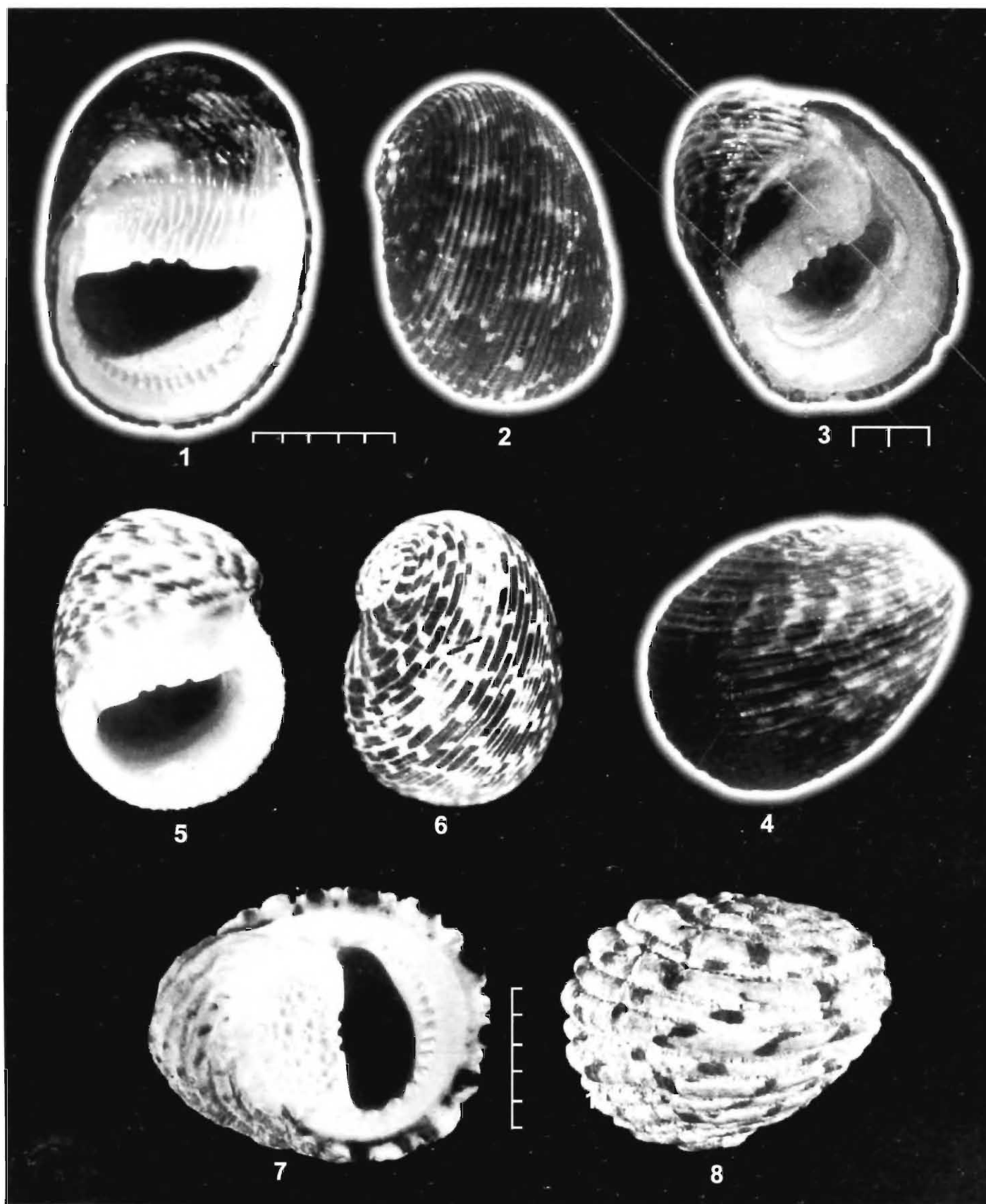
1-3. *Nerita (Nerita) undata* : Gujarat; 4,5. *Nerita (Theliostyla) patula* : Andamans; 6. *Pseudonerita sulculosa*; 7,8. *Nerita (Ritena) articulata*; 9. *Pseudonerita amoena*; 10,11. *Nerita (Ritena) insculpta* : Andamans.

Plate 14 : Neritidae



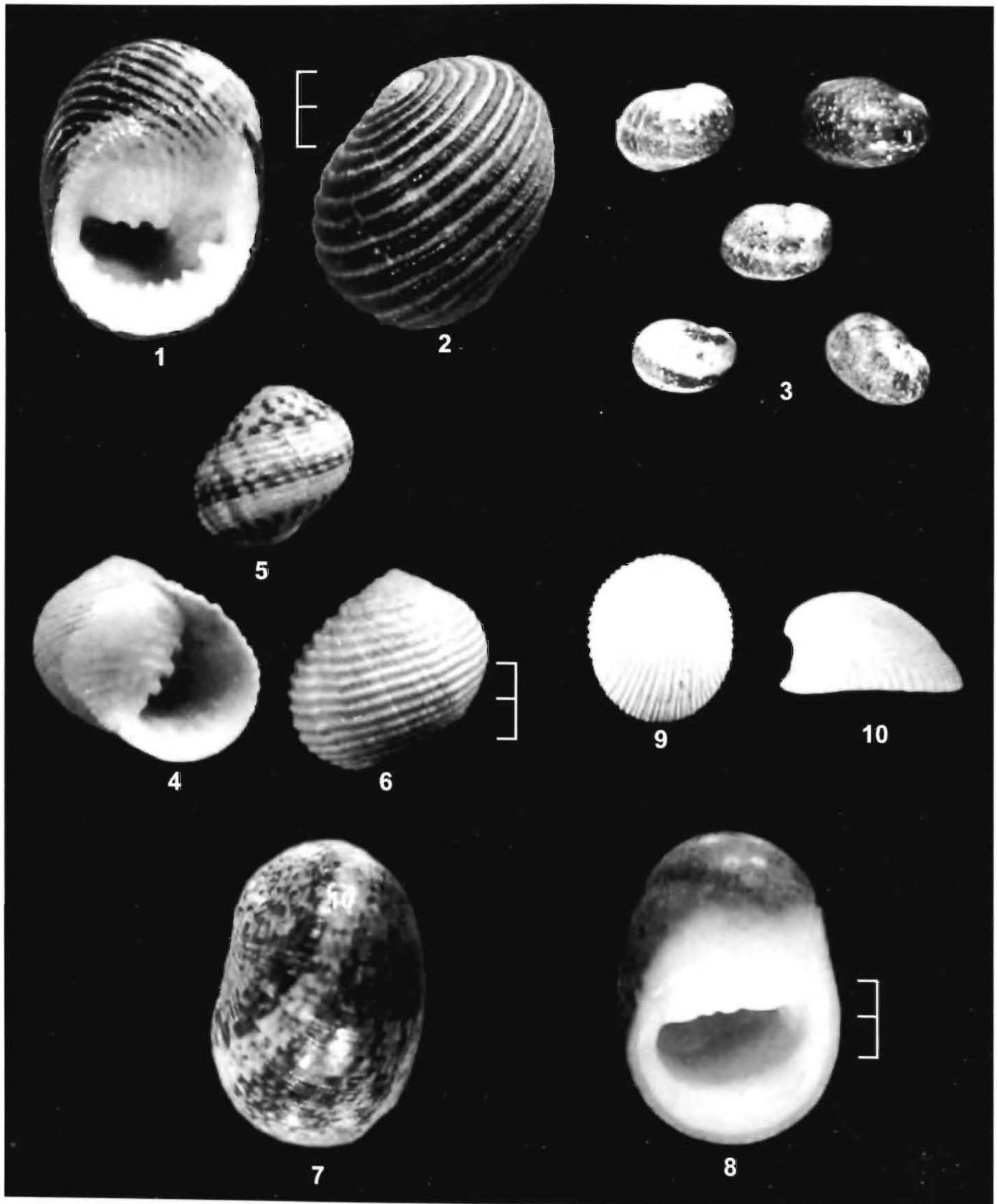
1-4. *Nerita (Theliostyla) albicilla* : Andamans; 5-7. *Nerita (Theliostyla) squamulata* : Chidiyatapu, South Andaman; 8, 9. *Nerita (Theliostyla) chamaeleon* : Devgad, Maharashtra; 10-13. *Nerita (Theliostyla) oryzae* : Mumbai.

Plate 15 : Neritidae



1,2. *Nerita (Ritena) grayana*; 3,4. *Nerita (Theliostyla) planospira*; 5,6. *Nerita (Ritena) maxima* : Chidiya tapu, South Andaman; 7,8. *Nerita (Theliostyla) textiles*, Veraval, Gujarat.

Plate 16 : Neritidae



1,2. *Nerita (Ritena) costata* : Car Nicobar; 3 a-e. *Pseudonerita amoena*; 4-6. *Nerita (Ritena) plicata* : Car Nicobar; 7,8. *Nerita (Ritena) polita* : Nan Cowry; 9,10. *Phenacolepas crenulata* : M 22001/4, Vanthivu Id., Gulf of Mannar.

in the middle, spire scarcely exerted, concavely flattened, nuclear whorls smooth and glistening white. Aperture broadly expanded, columellar callus smooth in the upper half but obscurely wrinkled in the lower half, columellar margin concave, with four stout teeth in the middle, outer lip thickened and expanded, with 20 to 40 fine teeth of uniform size on the interior and on either side with wide edentulous area. Sculptured with numerous flat spiral riblets separated by much narrower grooves. Colour grayish- black, sparingly interrupted with ash white, callus porcelaneous white, aperture white, outer lip flecked. Operculum pale gray with numerous round granules on the outer surface, internal surface smooth, light flesh red with two gray, somewhat broader bands parallel to the outer margin, apophyses well developed, anterior end flat and pale yellow.

India : Tamil Nadu : Gulf of Mannar (Pamban, Shingle Island); Andaman and Nicobar Islands. Indo-Pacific.

It occurs on rocks in shady and damp places in the supratidal zone not much exposed to waves. It occupies the highest landward zone among neritids. It is one of the common species in the Andaman and Nicobar Islands but uncommon on the mainland coast.

Nerita (Ritena) plicata Linnaeus, 1758

(Pl. 16, fig. 4–6 and Pl. 17, fig. 8)

Shell of medium size, up to 33 mm in height, globose, whorls three, rounded, spire prominently raised and clearly exerted beyond the level of the large, globular body whorl, apex pointed and sharply defined, sutures not distinct. Aperture relatively smaller and further narrowed by the teeth protruding into it; columella with a callus deposit bearing longitudinally elongated wrinkle-like ridges, some of the stouter ones produced below to form strong, widely set teeth on the columellar edge towards the aperture, teeth three, outer lip thick, sloping inward, with five teeth, the teeth at either end very strong and knob-shaped enclosing in between three or rarely five teeth. Sculptured with very strong, raised spiral ribs separated by deep and well excavated interstices, ribs generally weaker on the lower third of the body whorl. Colour mostly of uniform yellowish-brown or absolute white, often with numerous irregular dark spots, columellar callus glistening white. Operculum concave, yellowish-red with white dots, smooth except for the faintly granulated outer margin, which bear small dark membrane, internal surface slightly convex, intense flesh red and highly polished, rib strong and curved, peg very faint.

India : Lakshadweep, Tamil Nadu : Tranquebar, Madras; Andaman and Nicobar Islands, not known from the West Coast. Widely distributed in the Indo-Pacific.

It lives attached to rocks, pebbles or concrete pilings high on the shore. At some places the vertical range of the species is as high as littorinids and receive only spray of breaking waves.

***Nerita (Amphinerita) articulata* Gould, 1847**

(Pl. 13, fig. 7, 8 and Pl. 18, fig. 6)

Shell of medium size, up to 35 mm in height, oblong ovate, whorls 2 ½, rounded and rather narrow, spire lateral, blunt and somewhat depressed. Aperture with smooth columellar callus except for wrinkles on its upper margin, columella concave with three to four short teeth in the middle, outer lip margin thin with a deep inward slope, inner side thickened with 17 to 20 longitudinally elongated teeth, the posterior most two teeth larger than the rest and knob-shaped, a large edentulous gap between the upper limit of outer lip and the first tooth at the posterior end. Sculptured with numerous (25 to 35) purplish-black, fine, oblique spiral ribs, which often appear interrupted due to numerous white specks on the surface, interstices markedly broader than the ribs. Colour dark reddish-gray, aperture yellowish-white, callus conspicuously stained with yellow, outer lip margin fringed with black.

India : West Bengal : Port Canning, Sunderbans; Orissa : Mahanadi Estuary (Hukitola); Andamans. Indo-Pacific, Sri Lanka to Fiji Islands.

The snails generally occur on the roots and branches of mangroves.

***Nerita (Amphinerita) polita* Linnaeus, 1758**

(Figs. 24 & 25, Pl. 16, fig. 7, 8 and Pl. 17, fig. 1)

Shell of medium size, up to 38 mm in height, obliquely ovate and thick, whorls three, narrowly rounded, laterally compressed towards the aperture, body whorl large. Spire minute and more or less completely depressed. Aperture lunate, porcelaneous and polished, columella with thick and extensive callus, smooth and glossy, outer lip thickened, sloping steeply inwards, smooth, polished and scarcely toothed. Shell deeply impregnated with pigment, colour highly variable, greenish brown or yellowish brown, with two to three spiral bands of black or narrow ashy black, or white or reddish bands, columellar callus yellowish-white, outer lip fringed with yellow. Operculum smooth and gray in colour, outer margin with chestnut-brown zone traversed by numerous concentric ridges, rib strong with longitudinal striae, peg faint or lacking.

India : Karnataka, Tamil Nadu, Pondicherry, Andhra Pradesh, Andaman and Nicobar Islands. Widely distributed in Indo-Pacific.

The species occurs in the lower and mid-littoral zone. It has preference for the sandy regions of the coast where rocks also abound. It burrows into sand and spends the high tide period by remaining buried in the sand at the base of a rock. When the water recedes the snail is seen moving with sand over it. It is a highly polymorphic species.

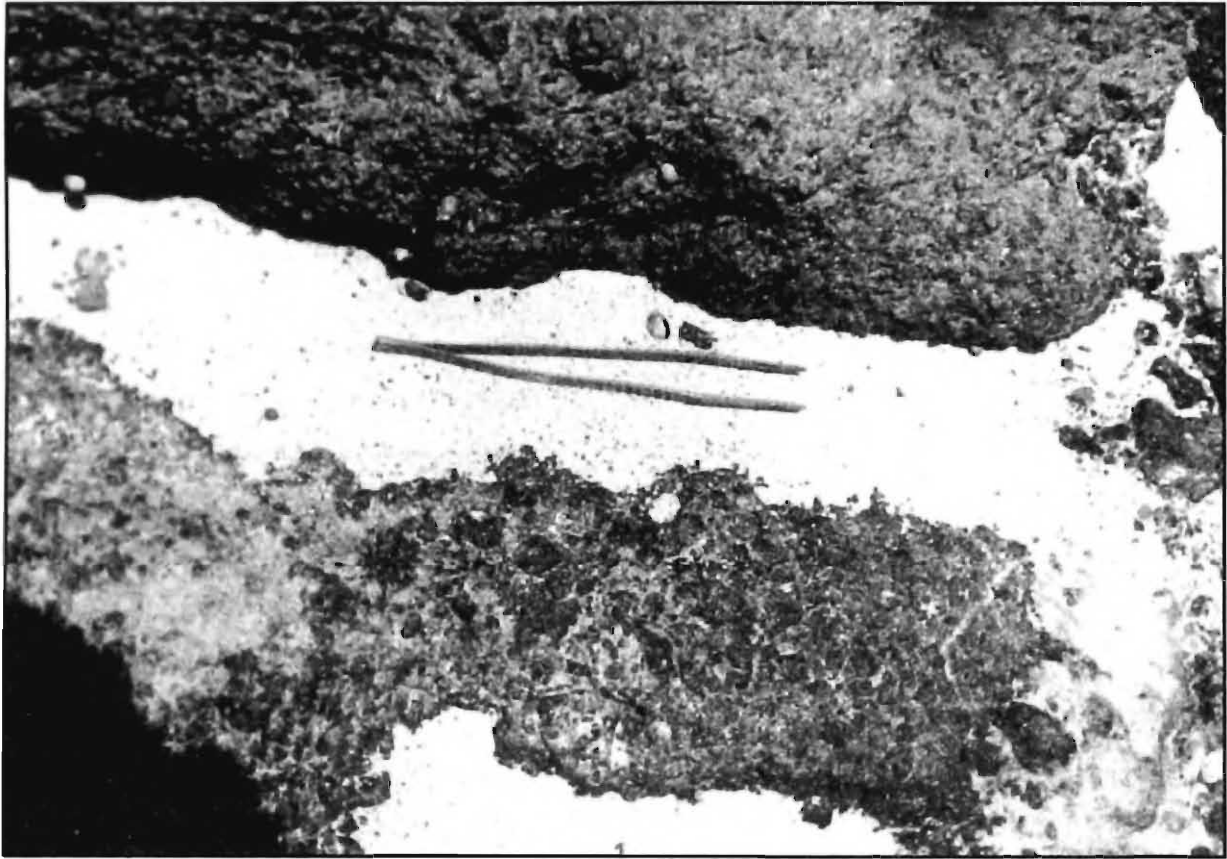


Fig. 24. Habitat of *Nerita polita*, Nancowry, Nicobars.

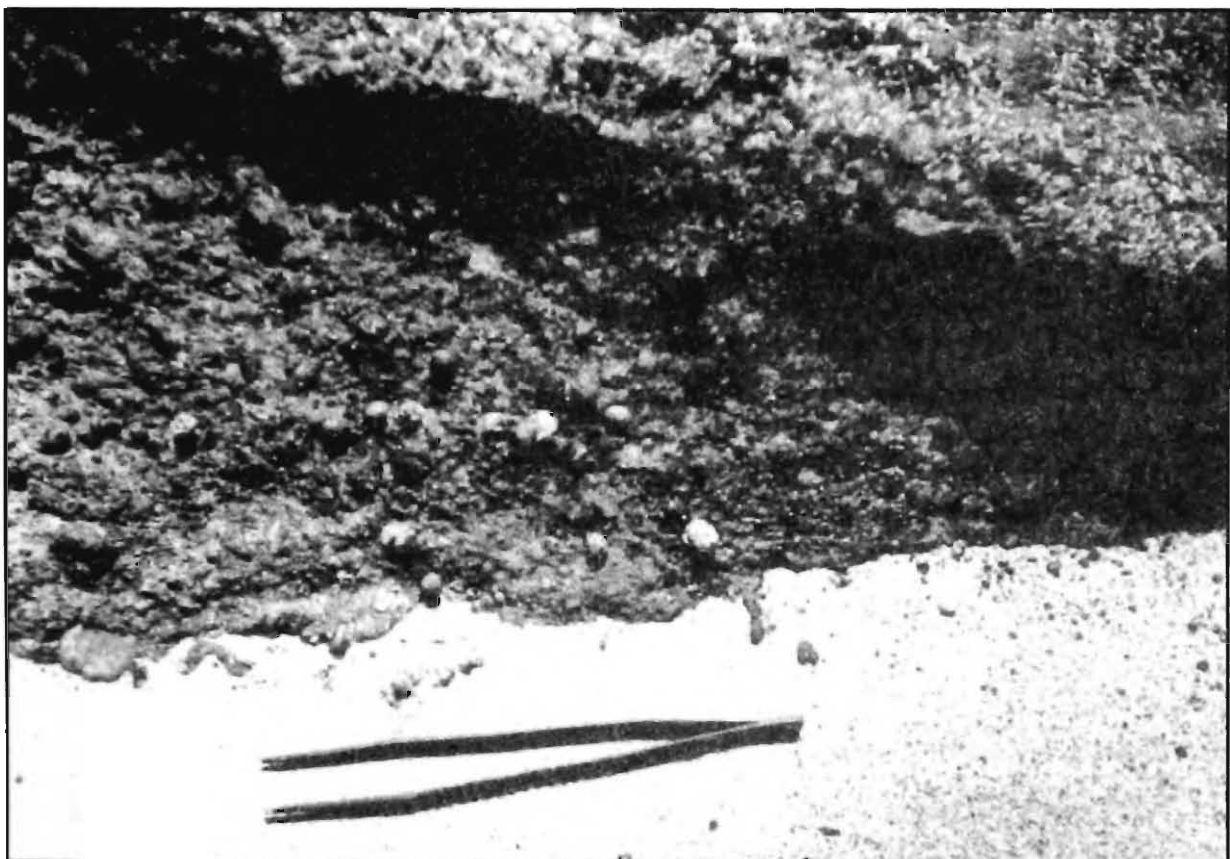


Fig. 25. Habitat of *Nerita polita*, Nancowry, Nicobars.

Nerita (Heminerita) insculpta Recluz, 1841

(Pl. 13, fig. 10, 11 and Pl. 18, fig. 4)

Shell small, up to 24 mm in height, obliquely ovate, strongly arched, whorls three, rather narrow, spire flatly impressed and small, apex blunt. Aperture semilunar, columella convex or straight, with two to four feebly developed teeth in the middle, outer lip raised extending up to the spire on the top, outer margin thin, sloping steeply inwards, inner side thickened, porcelaneous white, generally smooth or rarely with two weak or stout and longitudinally elongated teeth on the posterior part. Sculptured with 22 to 32 ribs of equal size, but in the upper half weak and strong ribs alternately arranged, interspaces densely cancellated with concentric striae. Colour a mixture of bright gray, black and white in different stretches, often with three black spiral bands. Operculum flat, thick and finely granulated, reddish-gray with white nucleus, inner surface dull gray.

India : Tamil Nadu, Andaman and Nicobar Islands. Sri Lanka to the Philippines, Australia and Polynesia.

The snail seems to prefer stones in the supratidal zone, where it was found crawling on the stones with algal encrustations. In many locations it co-exists with ellobiids and littorinids.

Pseudonerita amoena (Gould, 1847)

(Pl. 13, fig. 9 and Pl. 16, fig. 3a-f)

Shell small, up to 20 mm in height, ovate, thick, body whorl expanded, with scarcely raised spire. Aperture proportionately large, columellar margin with 10 to 12 very small teeth, outer lip thick, semicircular, projecting beyond columellar callus. Sculptured with spiral striae and rugose, axial growth lines. Colour shining purple blue or reticulated pattern of jet blue-black upon a cream or white base, aperture bluish-white or white tinged with yellow, outer lip margin fringed with black. Operculum smooth and dark gray, external margin fringed with brown coloured membrane, internally white, rib and peg yellowish on tips.

India : Gujarat, Andhra Pradesh: Kakinada Bay; Orissa : Rushikulya Estuary near Gopalpur; Andamans, estuaries and backwaters. Indo-West Pacific, not common.

Pseudonerita obtusa (Sowerby, 1841)

(not figured)

Shell small, up to 15 mm in height, transversely ovate, rather thin, whorls three, spire small, a little exserted. Aperture orbicularly ovate, columellar margin concave with 9 to 11 weak teeth, outer lip slightly thickened. Sculptured with very fine spiral striae, narrow and decussate. Colour greenish-olive, body whorl often with a dark green spiral band. Operculum externally brown,

flesh-red along the palatal margin, dark-gray along the parietal margin, finely striated dark red **membranous** fringe, internal surface smooth and dark brown, rib very oblique and blunt, orange **yellow** with tip being lighter, peg sharp and yellow.

India : West Bengal : Hugli River near Calcutta; Andamans, estuaries and backwaters.
Elsewhere: Myanmar.

Pseudonerita sulculosa (von Martens, 1879)

(Pl. 13, fig. 6)

Shell small, up to 8 mm in height, obliquely oval, almost hemispherical, whorls three, spire **lateral** and projecting. Aperture obliquely elliptical, columellar callus even, smooth, columellar **margin** concave with 9 to 11 strong teeth in the middle, teeth extended as ridges on to the **callous**, outer lip broadly arched. Sculptured with numerous fine, deep, spiral striae crossed by **axial** striae giving decussated appearance. Colour uniformly dark greenish gray. Operculum **brilliant** gray with black margin on the outer region, internally whitish, rib flat and very oblique, **peg** deeply depressed.

India : Orissa : Mahanadi estuary; West Bengal : Hugli River near Calcutta, Sunderbans.
Elsewhere: Indonesia.

It occurs in estuaries adhering to wood inside its bark and sometimes in the empty tunnels of shipworms.

The species resembles *P. obtusa* but can be distinguished from it by the presence of strongly **arched** coarse spiral striae, more projecting spire, broadly arched outer lip and bluish-gray **aperture**.

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- Subba Rao, N. V. 1980. On a new record of neritid, *Nerita (Theliostyla) patula* Recluz, 1841 (Mollusca : Gastropoda) from Andamans with a note on the species. *Rec. zool. Surv. India*, 77 : 71-74.
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Family PHENACOLEPADIDAE

Shell is very small and may be up to 7 mm in length. It is limpet-like with the apex situated towards the posterior region. Aperture is wide and rounded. Muscle scar is horseshoe shaped with an anterior opening. Shell is porcelaneous and its surface is sculptured with radiating ridges, which often may be nodulose due to the crossing of spiral cords. There is no operculum.

Head bears long subulate tentacles with eyes at their bases. Edge of the mantle bears numerous cirri. Mantle cavity consists of an elongate bipectinate ctenidium. Radula is rhipidoglossate with one strong central tooth flanked on either side by five laterals and numerous marginal teeth. Sexes are separate. Male has a penis and the female has a spermatophore sac.

These are offshore forms occurring at moderate depths. It is a small family embracing two genera and about 20 species. In India it is known by a single species.

Phenacolepas crenulata (Broderip, 1847)

(Pl. 16, fig. 9, 10)

Shell very small, up to 7 mm in height, white, thin, limpet-like, anteriorly arched convexly and posteriorly slightly concave, apex obtuse, at anterior third and recurved. Surface with strong radial ribs crossed by concentric threads forming small nodules at the intersections. Ribs more pronounced, close-set and shorter at posterior portion. Aperture broadly ovate occupying the whole ventral portion and with uneven margin. Interior of shell smooth with a finely grained narrow rim near the margin, muscle-scar horse-shoe shaped, colour uniformly creamy white on the exterior and white on the interior.

India : Tamil Nadu : Gulf of Mannar (Tuticorin, Krusadai Island, Mandapam). Indo-Pacific, moderately common.

Synonym : *Phenacolepas asperulata* : Satyamurti, 1952.

Order MESOGASTROPODA

Shell is mostly porcellaneous and operculate. It usually is conical with a high spire or of turreted shape. Mantle cavity has a monopectinate left etenidium, a bipectinate osphradium and usually a single hypobranchial gland situated on the right side. Radula is taenioglossate. Heart has a single auricle and a ventricle. Sexes are separate or sometimes united and with a complex reproductive system. Majority occurs in marine habitat with some on land or in freshwater.

It is the largest order embracing as many as 94 families. About 47 families are known to occur in India, three of these on land and two in freshwater. Among the marine families, the following common and better-known ones are dealt with below.

Family LITTORINIDAE

Periwinkles

Shell is small to medium in size, up to 40 mm in height, turbate to ovate-conical or pyramidal with a flattened or pointed spire, thin and light. Aperture is rounded to oval with a thickened columella and thin outer lip. Umbilicus is absent. Sculpture consists of spiral cords and axial growth striae. Operculum is solid and chitinous, paucispiral with lateral nucleus.

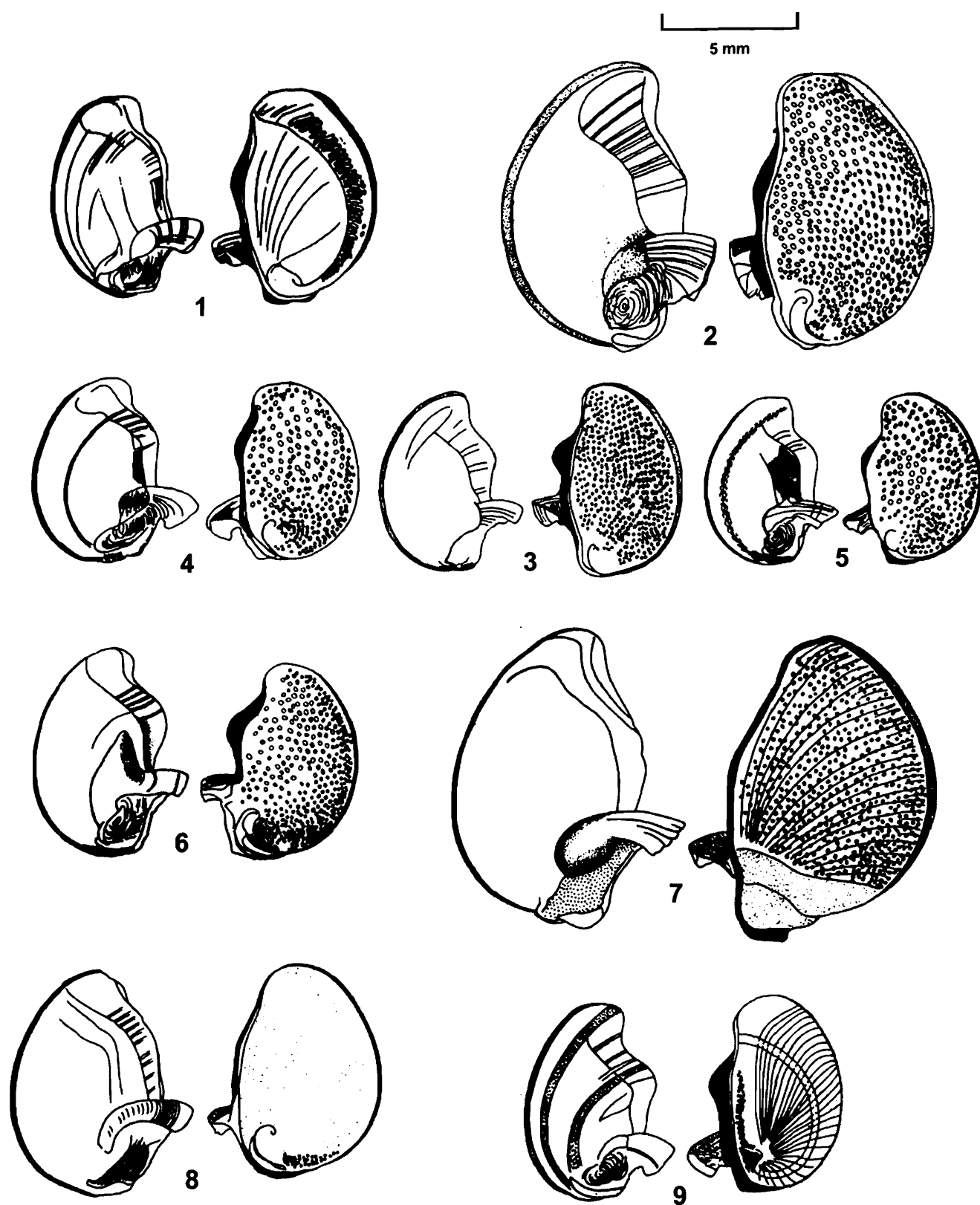
Head has a pair of tentacles with dark eyes situated at their outer bases. A short and broad anterior snout with the mouth at its tip. Foot is moderately sized, subcircular in front and obtuse behind. Mantle cavity has a vascularized roof and contain a small or reduced monopectinate ctenidium and osphradium. Radula is very long and taenioglossate (2-1-1-1-2). Digestive system consists of esophagus with a pouch and an elongate stomach containing style sac and gastric shield.

Sexes are separate. Male has a penis behind the right tentacle and the female has a well-marked groove to receive the sperms. Fertilization is internal, oviparous or ovoviviparous.

Periwinkles are cosmopolitan and are among the commonest snails in the intertidal zone, clinging to rocks or other hard substrate between the mid-tide and high tide lines. Some even occur a little above high tide limit receiving only occasional splashes of the breaking waves.

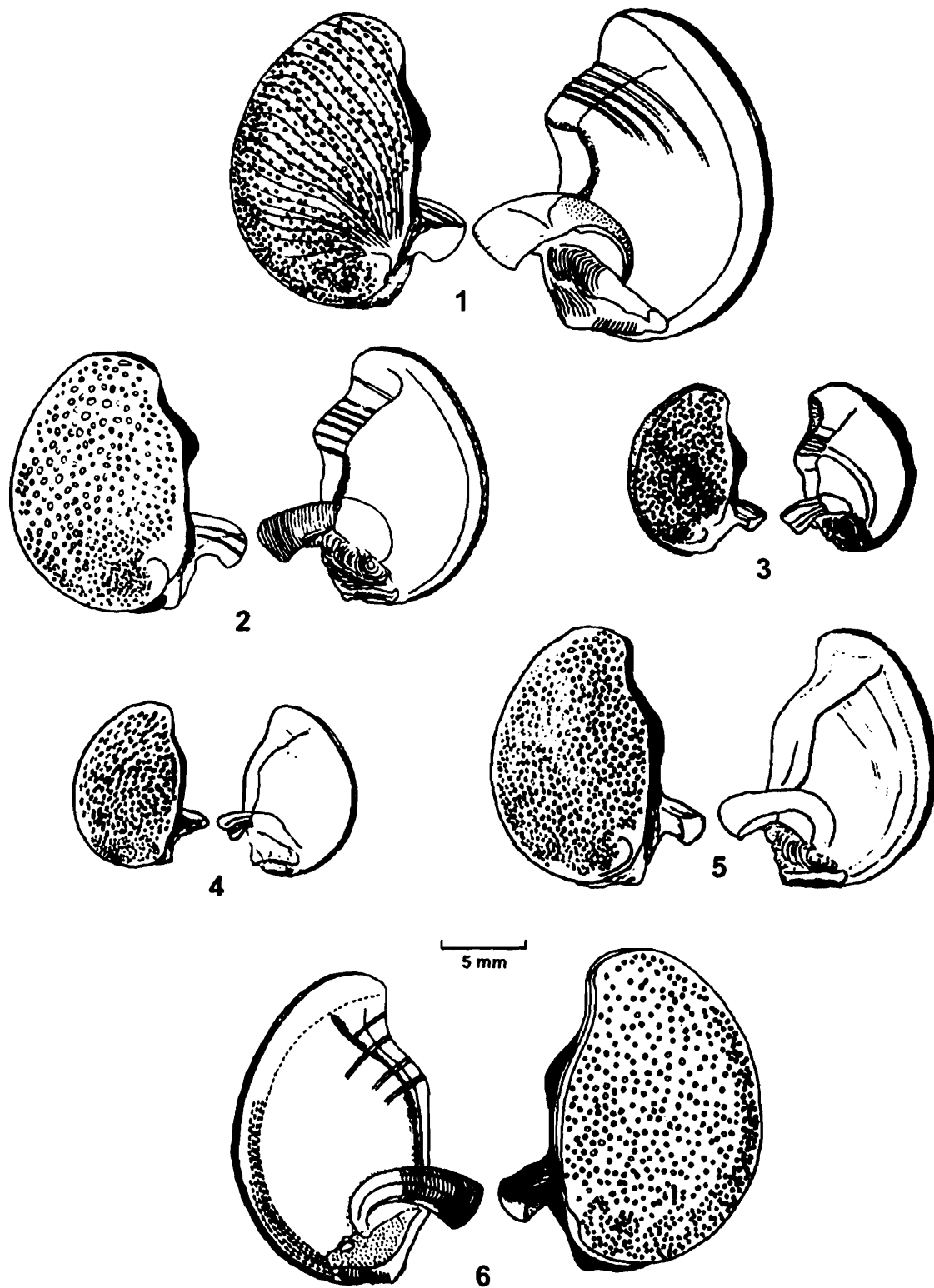
Although littorinids are common the identity of many species was not clearly established till recently. The contribution made by Rosewater (1970, 1972) brought some stability in the nomenclature of littorinid species and provided background for further studies. The most valuable studies on littorinids in recent years were by Reid (1986, 1989a, 1989b, 1992, 1998). Reid (1986) examined anatomical features of mangrove littorinids and revised a hitherto less known genus *Littoraria*. He recognized twenty species from mangroves in the Indo-Pacific province from where three species were known earlier. *Littorina scabra* species complex has been divided

Plate 17 : Opercula of Neritids



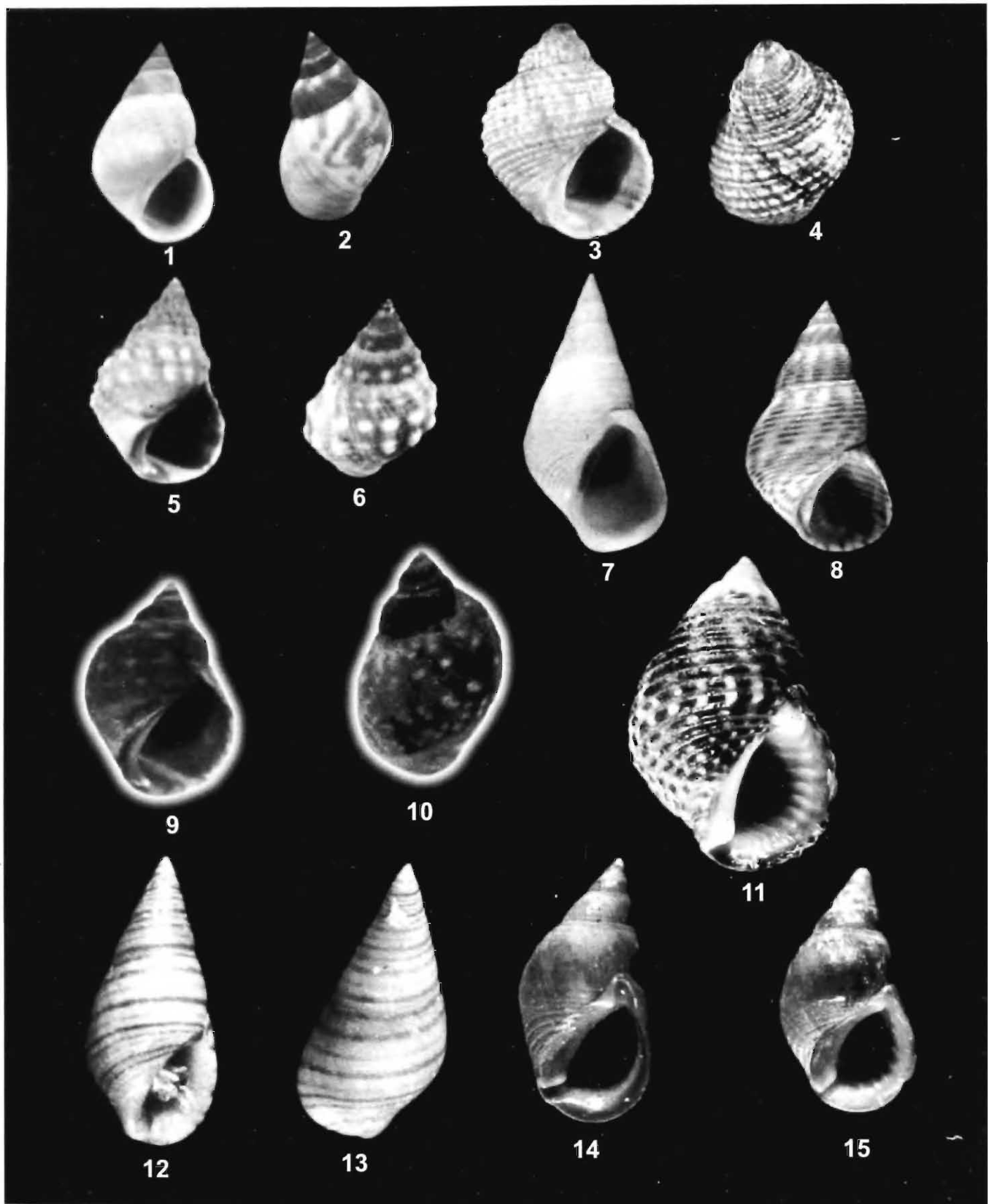
1. *Nerita polita*; 2. *Nerita textiles*; 3. *Nerita albicilla*; 4. *Nerita chamaeleon*; 5. *Nerita squamulata*; 6. *Nerita oryzarum*; 7. *Nerita costata*; 8. *Nerita plicata*; 9. *Nerita planospira*.

Plate 18 : Opercula of Neritids



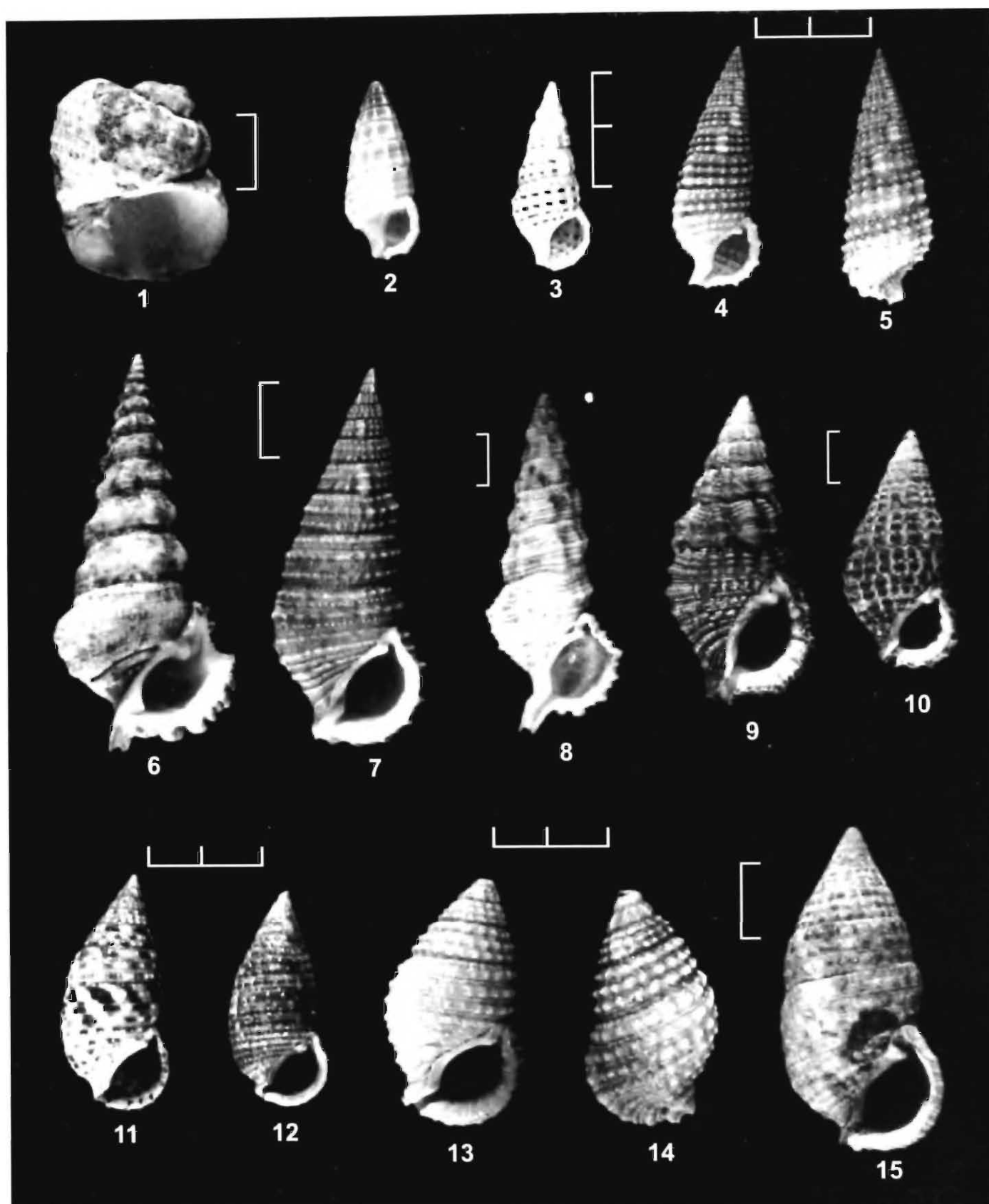
1. *Nerita maxima*; 2. *Nerita undata*; 3. *Nerita patula*; 4. *Nerita insculpta*; 5. *Nerita grayana*; 6. *Nerita articulata*.

Plate 19 : Littorinidae, Planaxide



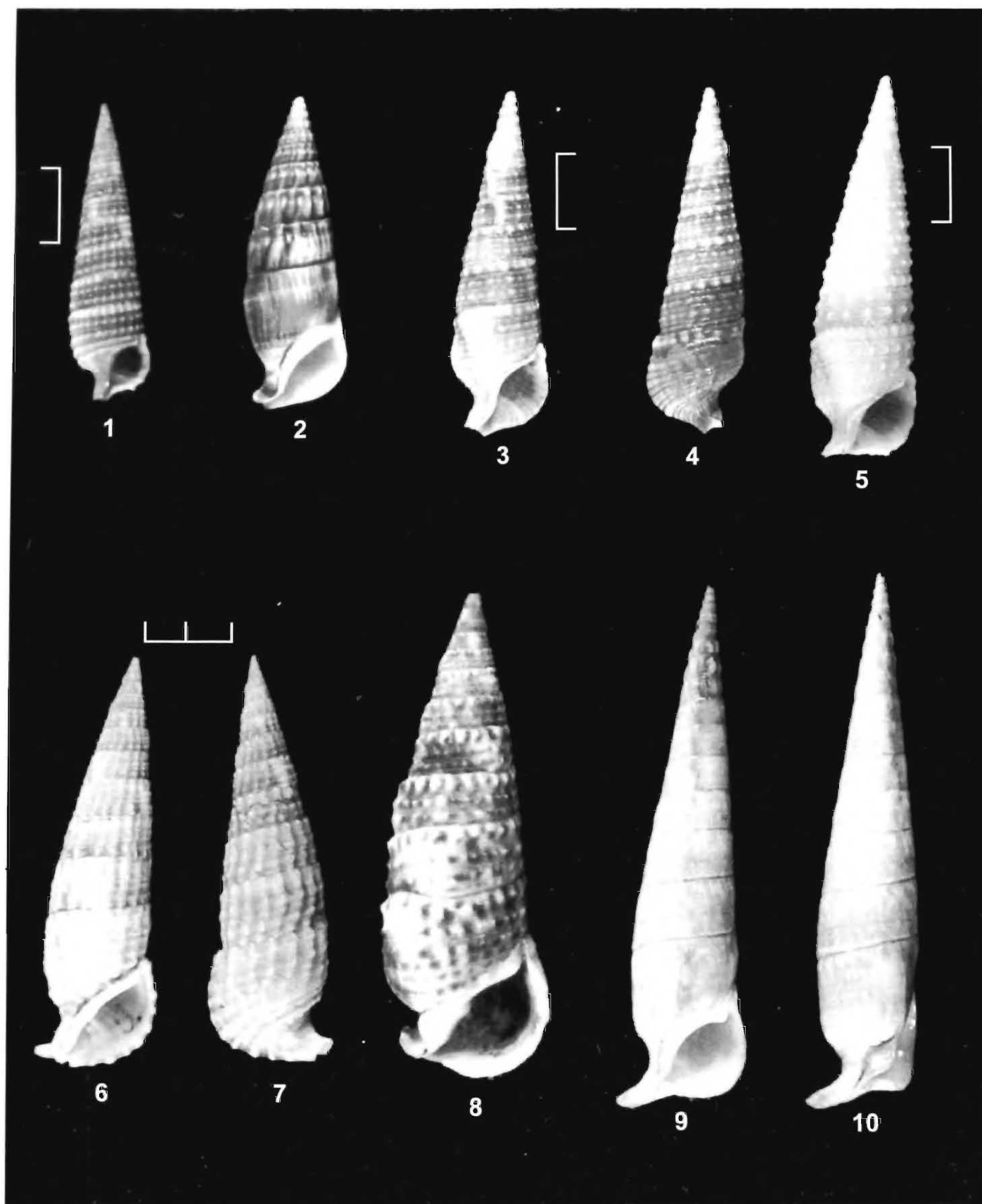
1,2. *Littoraria undulata*; 3,4. *Nodilittorina vidua* : x 3.4; 5,6. *Nodilittorina trochoides* : x4; 7. *Littoraria melanostoma*; 8. *Littoraria scabra*; 9,10. *Nodilittorina quadricincta*; 11. *Planaxis sulcatus* : M17254/2; 12,13. *Angiola lineata* : Lakshadweep; 14. *Planaxis niger*; 15. *Planaxis nicobarica*.

Plate 20 : Modulidae, Cerithiidae



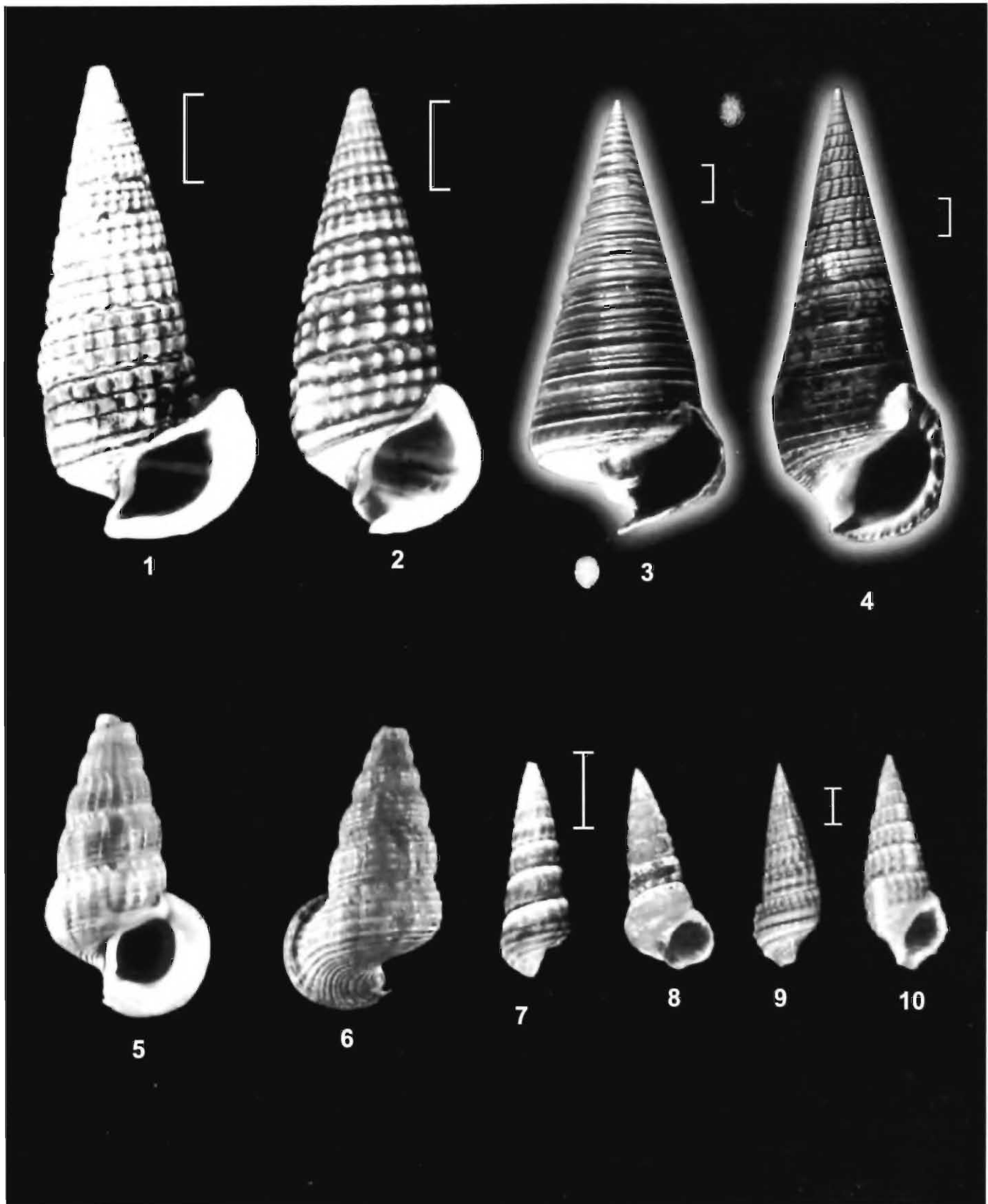
1. *Modulus tectum* : Minicoy Id; 2. *Cerithium balteatum*; 3. *Cerithium tenellum* : M20888/4, Kilakkarai, Gulf of Mannar; 4,5. *Cerithium scabridum* : M20870/4, Tuticorin; 6. *Cerithium nodulosum*; 7. *Cerithium coralium*; 8. *Cerithium columna* : Andamans; 9. *Cerithium traillii*; 10. *Clypeomorus batillariaeformis* : M 1139, Andamans; 11,12. *Cerithium petrosa gennesi* : Neil Island, Andamans; 13,14. *Cerithium bifasciata bifasciata* : M21298/4, Rameswaram beach, Tamil Nadu; 15. *Clypeomorus purpurostoma* : Car Nicobar.

Plate 21 : Cerithiidae



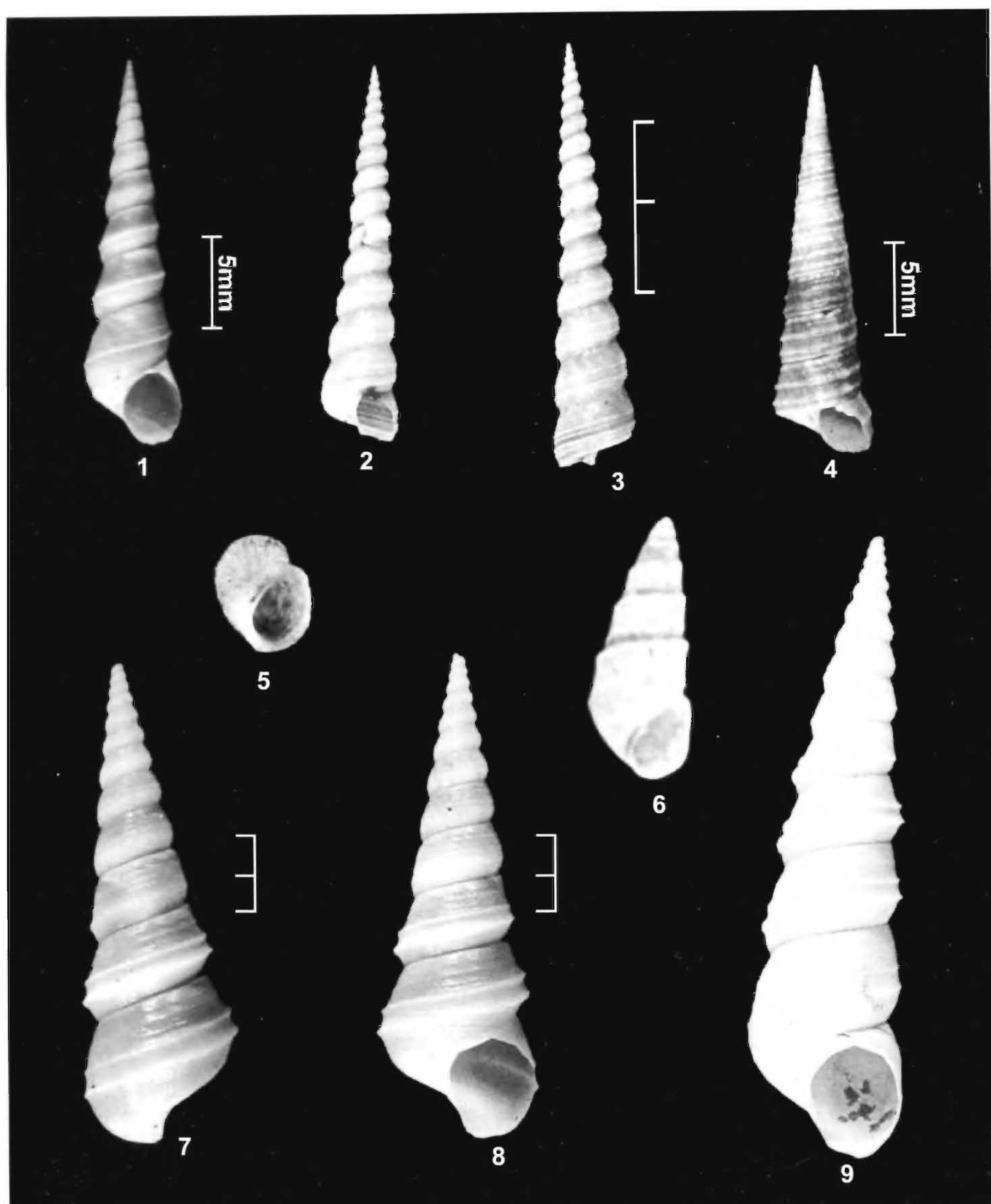
1. *Rhinoclavis sordidula*; 2. *Rhinoclavis vertagus* : Andamans; 3,4. *Rhinoclavis kochi polita* : Holotype, M4016/1; 5. *Rhinoclavis kochi* : Andamans; 6,7. *Rhinoclavis aspera* : Andamans; 8. *Rhinoclavis sinensis* : Krusadai Island, Gulf of Mannar; 9,10. *Pseudovertagus nobilis* : Andamans.

Plate 22 : Potamididae



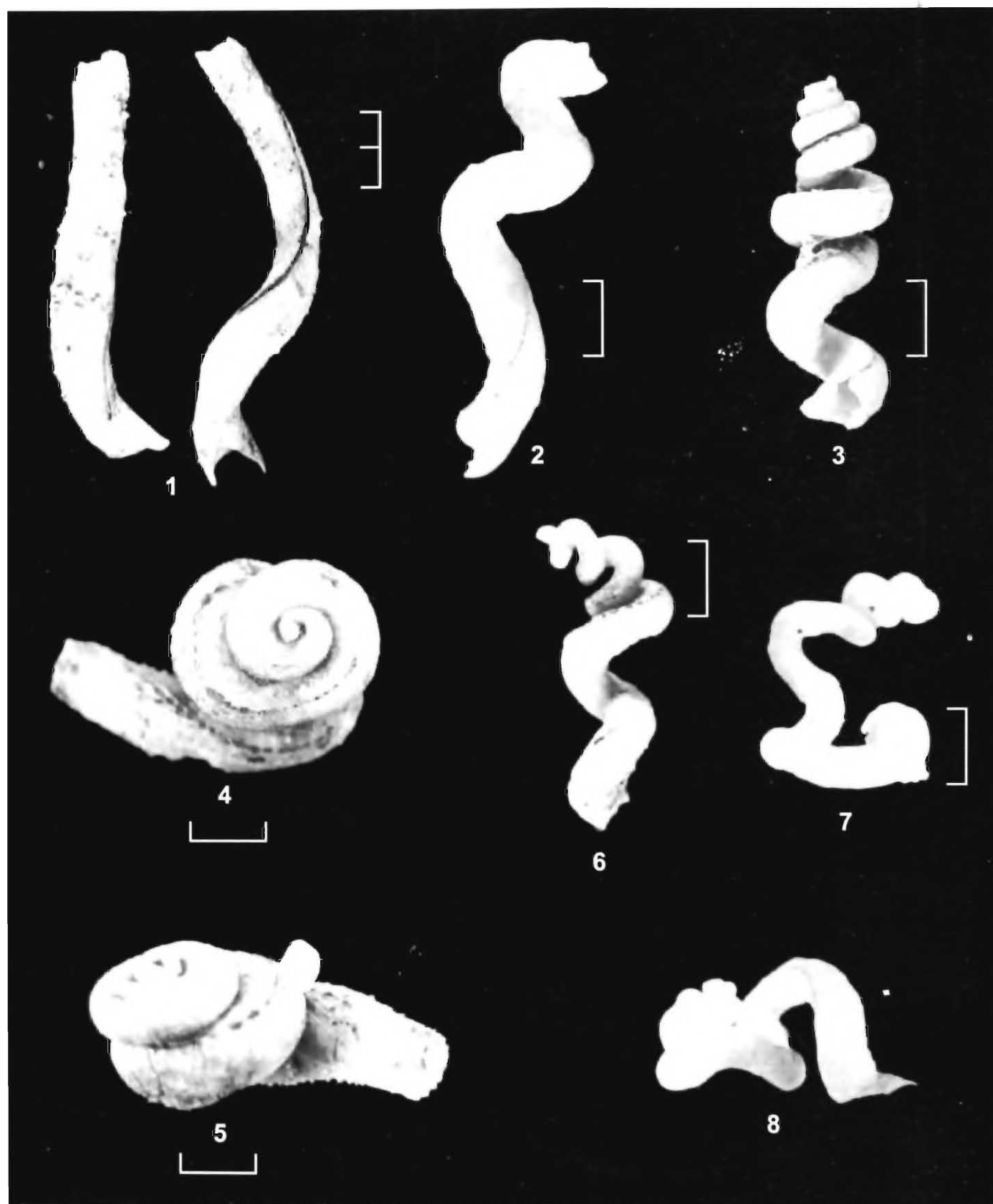
1. *Cerithidea alata* : Andamans, scale- 5mm; 2. *Cerithidea cingulata* : scale 5mm; 3. *Telescopium telescopium* : scale 5mm; 4. *Terebralia palustris* : scale 5mm; 5,6. *Cerithidea obtusa* : Sunderbans; 7,8. *Pirenella layardi bombayana* : Mumbai, scale 10mm; 9,10. *Batillaria angulifera* : scale 10mm.

Plate 23 : Turritellidae



1. *Turritella attenuata* : M20971/4 : off Chennai, 6-7 fms; 2,3. *Turritella columnaris* : M20964/4, Adirampattinam, Palk Bay; 4. *Haustator trisulcata* : M21428/4 : Setukkarai, Gulf of Mannar; 5. *Chilkaia imitatrix*; 6. *Diala semistriata*: M18034/3; 7-9. *Turritella duplicata* : Goa and Gulf of Kachchh.

Plate 24 : Siliquariidae



1. *Tenegodus anguina* : off Gopalpur, Orissa; 2,3. *Tenegodus tostus* : off Gopalpur, Orissa, 24 fms; 4,5. *Tenegodus trochlearis* : off Gopalpur, Orissa, 24 fms; 6-8. *Tenegodus cumingii* : Ganjam Coast, Orissa, 24-30 fms.

into seventeen species. In India only three species namely, *Littoraria scabra*, *Littoraria delicatula* and *Littoraria melanostoma* were reported from mangrove ecosystem. The collections of littorinids from the mangroves in India are to be reexamined to establish their identity.

The family, which includes about 100 species, has been divided into five subfamilies namely, Lacuninae, Littorininae, Tectariinae, Echiniinae and Bembiciinae. Only three subfamilies Littorininae, Tectariinae and Bembiciinae have their representation in India. The first is a large subfamily consisting of 13 genera, of which four genera namely, *Littoraria*, *Nodilittorina*, and less known genera *Peasiella* and *Mainwaringia*, are reported from India. Tectariinae is represented by *Tectarius granularis* and *Tectarius malaccanus*, which occur abundantly on the pillars of jetty in the Gulf of Mannar (Satyanarayana Rao and Sundaram, 1972). The last mentioned subfamily consists of *Bembicium* and *Cremnoconchus*. The latter genus is endemic to freshwater streams in Western Ghats, South India.

Subfamily LITTORININAE

Littoraria (Littoraria) undulata (Gray, 1839)

(Pl. 19, fig. 1, 2)

Shell small to medium in size, up to 25 mm in height, conical and thin. Aperture semi-oval. Sculptured with spiral cords. Shell cream coloured with dark or light brown dashes that form axial flame marks; columella violet.

India : Gujarat, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, Andaman and Nicobar Islands, common on intertidal rocks. Indo-Pacific.

Littoraria (Palustorina) melanostoma Gray, 1839

(Pl. 19, fig. 7)

Shell small, up to 27 mm in height, conical and thin, with six to eight flat-sided whorls. Aperture oval, columella weakly concave, glazed, with dark brown callus, outer lip often narrowly shouldered. Surface covered with lightly incised spiral cords, angulated keel on the body whorl. Colour pale yellowish, ornamented with closely spaced brown dashes arranged axially or in zigzag fashion, outer lip and interior of aperture pale yellow, columella dark brown, apex black.

India : West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Andamans. Elsewhere : Sri Lanka, Myanmar, Singapore, Philippines.

It occurs on small plants near the sea or on stems and leaves of mangrove trees or grasses. Unlike other littorinids, these are solitary in nature.

***Littorina (Littorinopsis) scabra scabra* (Linnaeus, 1758)**

(Pl. 19, fig. 8)

Shell largest among Indian littorinids, up to 40 mm in height, conical, fairly thin, light-weight, with seven to eight well rounded whorls, suture impressed. Aperture large, broadly rounded, columella smooth. Sculptured with flat or elevated spiral cords and axial lines, spire with a carinated keel, body whorl occasionally subcarinate or carinate at the periphery. Colour variable, pale gray or brown maculated with darker brown blotches below suture, columella white, outer lip with a white band on the interior.

India : East and West Coasts, Andaman and Nicobar Islands. Indo-Pacific, common.

It occurs on the trunks and branches of mangrove trees, a little above high tide limit.

***Nodilittorina (Nodilittorina) trochoides* (Gray, 1839)**

(Pl. 19, fig. 5, 6)

Shell small, up to 20 mm in height, thick, pyramidal, flattened, crescent shaped area on base adjacent to columellar callus. Sculptured with spiral rows of white nodules, one on each spiral whorl, two on the body whorl, one on the shoulder and the other on periphery, additional spiral cords present in the interspaces. Coloured bluish gray with white nodules and chocolate columella, aperture dark reddish brown with a narrow yellowish white band at the base of columella.

India : Maharashtra, Goa, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa. India to Marquesas in the Pacific. It is common in crevices of rocks in the littoral region.

The species has been referred to as *Nodilittorina pyramidalis* in all Indian records. The anatomical features and notes on ecology are given in Reid (1992).

***Nodilittorina (Nodilittorina) quadricincta* (Muhlfeldt, 1824)**

(Pl. 19, fig. 9, 10)

Shell smallest among littorinids, up to 16 mm in height, turbinata to elongate oval, base slightly flattened, whorls five to six, body whorl rather flat-sided at its centre and shouldered above. Aperture elongate oval, columella strongly produced, with callous and a flattened crescent shaped area at base. Surface sculptured with three low and well spaced spiral cords on the body whorl, cords bearing elongate, white nodules separated by brown coloured spaces. Coloured grayish white or brown, aperture with a white band at anterior junction.

India : Maharashtra, Goa, Tamil Nadu : Kanya Kumari, Gulf of Mannar (Mandapam, Tuticorin), intertidal rocks. Elsewhere : Sri Lanka.

The species is often confused with the more common *N. vidua* but can be distinguished by its slender shell, well developed shoulder on the body whorl, and also the pattern of nodules.

Synonym : *Nodilittorina leucosticta* (Phillippi, 1847)

Nodilittorina (Nodilittorina) vidua (Gould, 1859)

(Pl. 19, fig. 3, 4)

Shell small, up to 17 mm in height, subglobose, whorls five to six, sculptured with raised, granulose spiral cords and fine, microscopic wavy spiral threads in the interspaces. Colour grayish white, ornamented with reddish brown, flame-like axial blotches, columella dark brown.

India : Maharashtra : Bombay; Goa, Tamil Nadu, Pondicherry, Andhra Pradesh : Visakhapatnam, intertidal rocks. Indo-West Pacific.

All the Indian records of *Nodilittorina millegrana* (Philippi, 1848) should be referred to this species.

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Family PLANAXIDAE

Shell is somewhat similar to that of littorinids, but more solid, thicker and heavier. It is small to medium in size, up to 30 mm in height, conical and elongately ovate. Protoconch is generally glossy and pointed. A fibrous periostracum covers the shell. Aperture is lirate and angled above. Anterior canal is well developed. Posterior canal is also distinct and has a thick spiral ridge running inwards from its inner side. Outer lip is thickened and has 8 to 10 internal spiral grooves. Umbilicus is absent. Surface is either smooth or with spiral cords or grooves but without varices. Operculum is chitinous, almost smooth with subterminal, basal nucleus.

Head bears a pair of subulate tentacles with eyes at their outer bases. Foot is simple. Radula is taenioglossate. The snails are parthenogenic and males were not observed. Instead of pallial gonoduct the female has a ciliated mantle groove. Eggs are incubated in a special groove in the 'neck' region. There is a planktonic veliger larva.

Planaxids occur along with littorinids under rocks or in the rock crevices near high water mark in the intertidal zone. Although majority of species are marine a few occur, elsewhere, in freshwater also.

The family includes six genera, of which two namely, *Planaxis* and *Angiola* are represented in India.

Planaxis niger Quoy and Gaimard, 1834

(Pl. 19, fig. 14, 15)

Shell smaller than in *P. sulcatus*, up to 15 mm in height, thick, conical-ovate, whorls five to seven, protoconch consists of two smooth and white whorls. Aperture lirate, outer lip thickened, the inner edge prominently denticulate with 8 to 10 teeth, often in some old specimens teeth not visible, with distinct anterior and posterior siphonal canals, columella concave, with smooth callous. Sculptured with obsolete spiral striae on the spire whorls and top of the body whorl, base of the body whorl with three to six distinct, broad spiral cords. Colour dark brown throughout, aperture and columella shining pale brown.

India : Maharashtra : Bombay; Orissa, Andaman and Nicobar Islands. Indian Ocean.

It occurs in clusters along with littorinids in the crevices of rocks and boulders in the intertidal zone.

Synonyms : *Planaxis acutus* Krauss, 1848

Planaxis nicobaricus Frauenfeld, 1866.

Planaxis sulcatus (Born, 1780)

(Pl. 19, fig. 11)

Shell of medium size, up to 30 mm in height, solid, conical, body whorl slightly angular below. Aperture narrowly ovate, outer lip with distinct spiral ridges, columellar callus thick above, but thin and lamina-like below, minutely striate, anterior canal V- shaped, posterior canal a shallow groove. Surface sculptured with strong spiral cords separated by regular and uniform spiral grooves and oblique axial growth striae. Colour purple brown, with light gray spots on cords or oblique reddish brown stripes, outer lip edge and columellar base tinged with brown.

India : Maharashtra : Bombay, Devgarh; Lakshadweep, Tamil Nadu : Madras, Gulf of Mannar; Andhra Pradesh : Visakhapatnam; Andaman and Nicobar Islands. Indo-Pacific.

It was found abundantly in association with species of *Nerita*, *Littorina* and *Cerithium* in the intertidal region. It is common on coral stores in the infralittoral fringe. It feeds on algae, *Chaetomorpha* and *Enteromorpha compressa*.

Angiola lineata (da Costa, 1778)

(Pl. 19, fig. 12, 13)

Shell small, not exceeding 10 mm in height, glossy, thick, conically ovate. Aperture ovate, interior lirate, columella concave and smooth, with short and wide anterior canal. Sculptured with fine striae and distinct, narrow, orange-coloured spiral bands.

India : Lakshadweep. Mostly tropical Pacific.

It occurs in shallow lagoons and bays.

REFERENCE

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Family MODULIDAE

Shell is small to medium in size, turbanate bearing some resemblance to turban shells, with only a few whorls, and conical or depressed spire. Body whorl is broadly expanded, rounded and angulated at the periphery. Aperture is large, oblique to rounded. Columella is grooved, with a tooth at its base and narrowly umbilicate. Sculpture consists of spiral cords and axial riblets, five strong spiral cords on the base. Operculum is chitinous, moderately thin, rounded and multispiral.

Head bears long, cylindrical tentacles with eyes situated midway along their lengths. Foot is truncate anteriorly and narrow posteriorly. Mantle margin is fringed with papillae. Radula is taenioglossate and short. Alimentary system contains paired salivary glands, large hypobranchial and oesophageal glands, and a crystalline style in the stomach.

Sexes are separate. Male has no penis. Sperm duct is open. Female is with a well developed longitudinally open pallial gonoduct. Fertilization is internal with either direct or indirect development.

These occur in intertidal sands or offshore shallow waters and feed on diatoms, microorganisms and plants. It is a monogeneric family with 6 species distributed worldwide. A single species is known from India.

Modulus tectum (Gmelin, 1791)

(Pl. 20, fig. 1)

Shell small, up to 14 mm in height and 15 mm in diameter, broader than high, solid, whorls five, spire depressed, scarcely raised above the level of the body whorl, the latter broadly expanded; suture deep. Aperture obliquely ovate, columella smooth with a ridge-like tooth at its base, outer lip slightly expanded at its junction with the columella at the anterior end, posteriorly in line with the body whorl, umbilicus a tiny depression, but in some completely covered by the callus. Sculptured with coarse oblique folds on the angulated shoulder and irregular spiral ribs on the rest of the surface. Colour creamy-white with brownish dots, often in the form of two spiral bands on the body whorl.

India : Lakshadweep, Andamans, coral reefs. Indo-Pacific.

Family CERITHIIDAE

Horn Shells or Cerithid Snails

Shell is small to moderately large in size, generally not more than 80 mm in height but occasionally growing up to 100 mm, narrowly elongate and turreted with many whorls, normally as many as 9 to 16. Aperture may be small or large in comparison with the shell size and smooth. Anterior canal is long or short, oblique or sharply recurved. Anal canal is a sharply defined incision flanked in many by a posterior columellar plait. Columella is smooth, calloused in many and often with a fold. Outer lip is generally thickened and crenulated, but smooth in many and with lirations on the interior in some. Umbilicus is absent. Sculpture is highly variable, with spiral cords, axial ribs, nodules or varices. There is a high degree of intraspecific variability among the species, especially in those belonging to the genera *Cerithium* and *Clypeomorus*. Colour is also variable, white to dark brown. Operculum is horny, thin, brown, usually multispiral with an eccentric nucleus.

Head bears two, long cylindrical tentacles with eyes at their outer bases. Foot is short and broad. Mantle cavity contains a weak, monopectinate ctenidium, long thin and bipectinate osphradium. Radula is taenioglossate. Digestive system consists of a pair of salivary glands, an oesophageal gland, stomach with a gastric shield, a style sac enclosing a large crystalline style.

Sexes are separate. Male has no penis but there are spermatophores to store sperms. Pallial gonoduct is well developed and longitudinally open. Female has a sperm collecting pouch, a receptaculum seminis, albumen and capsule glands. Fertilization is internal and development may be planktotrophic or lecithotrophic.

Unlike potamidid snails, these occur in clear marine intertidal or shallow water on sand rubble substrates as epifauna or partially burrowing around rocks. These are microphagous herbivores and some feed on algal detritus. A few occur in estuarine habitats.

The family is divided into two subfamilies, namely Cerithiinae and Orectospirinae (monogeneric). The former, known by 20 genera, is represented in India by three widely distributed genera. The family includes an estimated 200 species in all, of which 25 species were so far reported from India.

Subfamily CERITHIINAE

Cerithium balteatum Philippi, 1848

(Pl. 20, fig. 2)

Shell small, up to 25 mm in height, turreted and acuminate, 9 to 12 well demarcated whorls. Aperture ovate, columella with thin callus, outer lip thickened, and crenulated, with weak, elongate denticles on the interior, sometimes obsolete, anterior anal long and tubular, anal

canal short but well defined by the presence of parietal columellar ridge. Early whorls sculptured with fine spiral striae, base of the body whorl deeply excavated, body whorl with six to eight beaded spiral cords. Colour white or cream.

India : Tamil Nadu : Gulf of Mannar; Andamans. Mainly Pacific.

It occurs in sandy stretches in the reef ecosystem.

Synonym : *Cerithium planum* Anton, 1833.

***Cerithium columna* Sowerby, 1834**

(Pl. 20, fig. 8)

Shell of medium size, up to 32 mm in height, turreted and fusiform, 9 to 13 whorls, rough and ventricose, sutures distinct, body whorl wide. Aperture large, expanded, subcircular, anterior canal long, tubular and reflected, anal canal short and bordered by parietal columellar plait. Outer lip corrugated, thick with furrows on the interior, columella concave with heavy callus. Sculptured with many rows of larger and smaller spiral cords with occasional chestnut or chocolate dots and irregular transpiral undulations which bulge into crest making whorls angular in the middle, a prominent varix opposite aperture. Coloured cream or pale yellow, mottled or speckled with reddish brown, aperture and columella white.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Andamans, not common. Red Sea to Australia and Polynesia.

It occurs in the intertidal to subtidal zone of reef ecosystem.

***Cerithium coralium* Kiener, 1841**

(Pl. 20, fig. 7)

Shell moderately large, up to 45 mm in height, elongate, turreted, with 13 to 18 straight sided whorls, sutures deep. Aperture narrow and fusiform, with short and broad anterior canal, and a deep anal canal bordered by columellar plait, columella with thick callus, outer lip thickened and crenulated with elongate denticles on the interior. Sculptured with two spiral cords on the top spire whorls, three major beaded spiral cords on the other whorls crossed by axial ribs, body whorl with five or six beaded spiral cords, interspaces on all the whorls with fine spiral striae, a strong varix opposite the aperture, varices randomly placed on other whorls. Coloured dark brown, beads dark, aperture white. Operculum corneous, dark brown, thick with excentric nucleus.

India : Maharashtra : Bombay; Tamil Nadu : Vellar river mouth; Andhra Pradesh : Visakhapatnam; Andamans : Port Blair. Indo-West Pacific, mangrove swamps.

***Cerithium nodulosum* Bruguiere, 1792**

(Pl. 20, fig. 6)

Shell large, up to 100 mm in height and 45 mm in diameter, 14 to 18 whorls, heavy and thick. Aperture large, with well developed anterior siphonal canal, oblique and slightly reflected to left of shell axis, anal canal prominent and bordered inside by strong parietal columellar plaits, outer lip thick, flaring, with a claw-like extension anteriorly on to the anterior canal, deep spiral grooves on the interior, columella strongly concave, with narrow thick callus. Sculptured with strong, swollen nodules, and smooth, narrow spiral cords, crossed by numerous axial riblets, body whorl with a strongly excavated base and sculptured with five spiral, nodulose cords, and a distinct nodulose, subsutural spiral cord. Colour white or cream and mottled with dark brown, aperture white.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-West Pacific.

It occurs in the reef ecosystem on shoreward reef edge.

***Cerithium scabridum* Philippi, 1848**

(Pl. 20, fig. 4, 5)

Shell small, up to 23 mm in height, slender and oblong, turreted, with 10 to 14 whorls and distinct sutures. Aperture narrow and obliquely ovate, with short and wide anterior canal and shallow posterior canal, flanked by strong columellar plait, outer lip thickened outside and crenulated inside, columella concave with strong callus. Sculptured with two or three dominant spiral cords crossed by strong axial ribs, nodular at intersection and flattened spiral lirae on interspaces, body whorl with five nodulose spiral cords on the top and five to seven weakly beaded spiral cords on the base, several irregularly arranged varices on the earlier whorls, a prominent varix on the body whorl opposite the aperture. Colour white with reddish brown spots on cords and nodules, aperture and columella white.

India : Tamil Nadu : Madras, Gulf of Mannar. Elsewhere : Red Sea and Persian Gulf.

It occurs in protected mid-littoral rocky shore habitats.

Synonym : *Cerithium carnaticum* Melvill and Standen, 1898 (Type-locality : Madras).

***Cerithium tenellum* Sowerby, 1855**

(Pl. 20, fig. 3)

Shell small, up to 18 mm in height, slender and thin, with 15 whorls. Aperture small and rounded, with short and wide anterior canal and a distinct anal canal bordered by parietal columellar callus, outer lip thick, crenulated and strongly convex, columella with thick callus. Sculptured with numerous irregular white varices, three spiral rows of equal sized nodules on

the upper part of the whorl at the periphery, connected by spiral cords, body whorl with five main spiral cords and large varix opposite the aperture. Colour white, nodules white chestnut or chocolate coloured, often with one or more thin chocolate coloured spiral lines, aperture purple brown.

India : Tamil Nadu : Gulf of Mannar, not common. Indo-West Pacific.

Its habitat seems to be sandy bottom of lagoons near reef ecosystem.

***Cerithium traillii* Sowerby, 1855**

(Pl. 20, fig. 9)

Shell of medium size, up to 37 mm in height, elongate and turreted, with 15 to 17 straight sided whorls, pointed apex. Aperture ovate, outer lip rounded, expanded, thickened outside and interior crenulated; short, tubular and oblique anterior canal and constricted posterior canal. Sculptured with regular spiral rows of beaded striae alternating with fine thread-like striae, body whorl with five beaded major spiral cords and a prominent varix opposite the aperture. Colour white, beads chestnut or chocolate coloured; varices, early whorls and aperture white.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Andamans. Indo-West Pacific, Lakshadweep to Philippines, Australia and Fiji Islands. Common on the under surface of coral stones in the infralittoral fringe.

***Clypeomorus batillariaefornis* Habe and Kosuge, 1966**

(Pl. 20, fig. 10)

Shell small, up to 26 mm in height, thick, with 10 convex whorls, suture slightly incised and indistinct. Aperture ovate, columella with slight callus, outer lip thick, weakly crenulated, lirate on the interior, anterior canal short, narrow and slightly reflected, anal canal deeply incised groove flanked by columellar plait. Sculptured with nodulose spiral cords, four to five on the penultimate whorl, nine to twelve cords on the body whorl, interspaces with fine undulating spiral threads, nodules of unequal size; with one or more varices on whorls. Colour light cream, spiral cords with alternating dark brown and white spots, aperture and columella white.

India : Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar (Rameswaram, Pamban, Mandapam); Andhra Pradesh : Visakhapatnam; Andamans. Indo-Pacific, common, widely distributed.

It occurs on hard substrate at the upper midtide level.

Synonym : *Cerithium moniliferum* Kiener, 1841.

***Clypeomorus bifasciata bifasciata* (Sowerby, 1855)**

(Pl. 20, fig. 13, 14)

Shell of medium size, up to 30 mm in height, slender and elongate, with 10 to 12 whorls. Aperture small, oval, columella with slight callus, outer lip thick, often with lirations on the interior, anterior canal short but deep, anal canal notch-like bordered by parietal columellar plait. Penultimate whorl sculptured with three equally spaced, spiral, beaded cords, enclosing in between them fine spiral striae, body whorl with six or seven prominent, beaded spiral cords, enclosing in between inconspicuous secondary threads. Colour variable, white with blotches of brown or black, beads dark, aperture and columella white.

India : Maharashtra : Bombay; Goa, Karnataka : Devgad; Tamil Nadu : Gulf of Mannar, Palk Bay; Andhra Pradesh : Visakhapatnam; Andaman and Nicobar Islands. Indo-Pacific, widely distributed from Persian Gulf to Japan, Australia and Phoenix Bay.

It occurs on hard or loose rocky substrata near the high water mark. It is confined mostly to the continental regions and high island groups of the Indo-West Pacific.

Synonyms : *Cerithium morus* Lamarck, 1822

Clypeomorus clypeomorus Jousseaume, 1888

***Clypeomorus petrosa gennesi* (Fischer and Vignal, 1901)**

(Pl. 20, fig. 11, 12)

Shell small, up to 22 mm in height, thick, whorls 11 to 12, elongate and pupiform, sutures distinct. Aperture ovate, small, with short and wide anterior canal, posterior canal a small incision flanked by parietal columellar plait, outer lip not very thick, extends slightly below the anterior canal. Sculptured with nodulose spiral cords, interspaces with smooth fine spiral striae, body whorl with a large dorso-lateral varix. Colour dull grayish white with darker nodes and white aperture.

India : Andamans. Indian Ocean.

***Clypeomorus purpurostoma* Houbrick, 1985**

(Pl. 20 fig.15)

Shell of moderate size, up to 25 mm in length and 10 mm width, turreted with 10-12 whorls, pupiform in outline, whorls moderately inflated, body whorl large, slightly over half of the shell length, sculptured with beaded spiral cords, spiral lirae and spiral lines, body whorl with a prominent subsutural spiral cord and large varix on right dorsal surface, an obsolete varix opposite outer lip. Aperture oval and small, columella with narrow parietal callus, siphonal

canal short, slightly reflected, posterior canal indistinct and bordered by distinct columellar fold, base of outer lip smooth bearing weak spiral lirae on the interior, base of outer lip extends over anterior canal. Colour white ornamented with brown blotches and spiral brown dots, beads dark brown. Aperture and columella purple coloured. Operculum thin, corneous with eccentric nucleus.

India : Andamans, Indo-West Pacific; more common in the Pacific.

It occurs sympatrically in association with *Clypeomorus bifasciata bifasciata*, and *Clypeomorus batillariae formis*, but at lower levels than these species in the intertidal zone.

***Pseudovertagus (Pseudovertagus) nobilis* (Reeve, 1855)**

(Pl. 21 fig. 9,10)

Shell largest among Indian cerithides, up to 100 mm in length and 35 mm in width, solid, with 16 whorls. Body whorl smooth except for a few spiral cords on base, upper few whorls sculptured with prominent and fine spiral cords and axial riblets, middle whorls smooth with conspicuous varices. Aperture ovate, smooth, siphonal canal very long, narrow and tapering, anal canal prominent with a conspicuous columellar ridge, outer lip smooth, its base extends over columella, columella smooth, with broad and raised columellar callus. Colour cream and tinged with olive. Operculum not seen.

India : Andamans, rare represented by only a single specimen. It is a first record from India. Indo-Pacific: It has a disjunct geographic range from a Mozambique and Zanzibar to Madagascar, and in the Pacific from the Philippines and Mariana Islands to New Caledonia in the south (Houbrick, 1978).

***Rhinoclavis (Rhinoclavis) aspera* (Linnaeus, 1758)**

(Pl. 21, fig. 6, 7)

Shell moderately large in size, about 50 mm in height, narrowly elongate, whorls 12 to 14, spire proportionately larger than the body whorl. Aperture obliquely oval, outer lip thick, smooth but slightly fluted. Columella with callous deposit extending freely above, with a central fold, anterior canal long and recurved, posterior canal short. Sculptured with strong almost continuous angulated axial ribs crossed by five to six spiral cords on each whorl, but more on the body whorl, periphery of the body whorl and below with three distinct beaded spiral cords. Colour cream, ornamented with brown lines, aperture and columella glistening white.

India : Andamans, very rare. Indo-Pacific, common.

It occurs in sandy areas near coral reefs.

Rhinoclavis (Rhinoclavis) sinensis (Gmelin, 1791)

(Pl. 21, fig. 8)

Shell moderately large in size, up to 52 mm in height, solid and heavy, whorls 13 to 14, broader than in the other species of the genus, whorls angular, sutures not distinct. Aperture squarish, outer lip simple and slightly expanded, columella with callous and a rounded flange near the anterior canal, with a central fold on the inside, anterior canal long and recurved, posterior canal rudimentary. Sculptured with spiral rows of nodules, the row just below the suture larger than others, nodules regular and well spaced, rounded or often spinose, fine axial and spiral threads in between the rows of nodules, body whorl with 10 to 15 nodulose cords and obsolete lateral varix opposite the aperture. Colour creamish, with irregular spots of purple brown, spiral cords ornamented with regular purple brown spots, aperture and columella white.

India : Gujarat : Port Okha; Maharashtra : Bombay; Goa, Lakshadweep, Tamil Nadu : Gulf of Mannar; Andhra Pradesh : Visakhapatnam, common. Indo-Pacific.

It generally occurs in sandy stretches near reef flats or under rocks in the intertidal zone.

Synonym : *Cerithium obeliscus* Bruguiere, 1792.

Rhinoclavis (Rhinoclavis) vertagus Linnaeus, 1767

(Pl. 21, fig. 2)

Shell moderately large in size, up to 58 mm in height, solid and heavy, narrowing anteriorly, 12 to 13 whorls, sutures deep and uneven. Aperture narrowly ovate, outer lip thickened, smooth and slightly expanded, columella with callus and a central fold, shallow groove around callus, anterior canal long and recurved, anal canal rudimentary. Sculptured with strong axial ribs and spiral cords on the spire whorls except the protoconch and the first few whorls, ribs become obsolete on the penultimate whorl and almost absent on the body whorl. Colour light to dark brown, early whorls, aperture and columella white.

India : Andamans, very rare. Elsewhere : Northern Australia to New Hebrides and Ryukyu Islands.

It occurs in sandy areas of shallow water lagoons.

Rhinoclavis (Proclavis) kochi (Philippi, 1848)

(Pl. 21, fig. 3-5)

Shell smallest in the genus, up to 26 mm in height, solid and glossy, whorls 13 to 14, sides straight. Aperture with reduced posterior canal and recurved anterior canal. Sculptured

with five to six spiral cords on all the whorls, but body whorl with more number, subsutural cord on each whorl more prominent than others, an obsolete varix opposite the aperture. Colour pale brown, often with fine brown spiral lines, top whorls light cream, columella white.

India : Andamans, very rare. Widely distributed in the Indo-Pacific.

***Rhinoclavis (Proclavis) sordidula* (Gould, 1849)**

(Pl. 21 fig. 1)

Shell small, up to 25 mm in length, whorls 15-17 with a tapering spire. Aperture ovate, one fourth the length of the shell, outer lip crenulated, distinct anal canal and short anterior canal, a weak columellar plait in the middle of the columella. Sculptured with three dominant spiral cords and weak beaded spiral cord on each whorl, three to four indistinct spiral striae and fine riblets between the cords, axial riblets cross over the spiral cords forming beads at the intersections, body whorl with five strong beaded spiral cords and axial riblets on upper two thirds and seven weak spiral cords on the lower part thus giving the shell reticulated and beaded appearance. Operculum corneous, chestnut coloured, ovate, paucispiral with well developed eccentric nucleus.

India : Andaman Islands. From Persian Gulf to Zanzibar, Malaysia and Indonesia. More common in Pacific from Japan to Fiji.

The species is reported for the first time from India.

The following species were also reported from India.

- | | |
|--|--|
| 1. <i>Cerithium africanum</i> Houbrick, 1992. | Port Blair, Andamans |
| 2. <i>Cerithium caeruleum</i> Sowerby, 1855. | Okha, Gulf of Kachchh |
| 3. <i>Cerithium citrinum</i> Sowerby, 1855. | Tuticorin, Port Blair |
| 4. <i>Cerithium dialeucum</i> Philippi, 1849. | Port Blair, Long Island,
Andamans |
| 5. <i>Cerithium punctatum</i> Bruguiere, 1792 | Andamans |
| 6. <i>Cerithium rostratum</i> Sowerby, 1855 | Port Blair |
| 7. <i>Cerithium torresi</i> E.A. Smith, 1884 | Bombay, Karwar, Tuticorin,
Andamans |
| 8. <i>Cerithium zonatum</i> (Wood, 1828) | Bombay |
| 9. <i>Clypeomorus subbrevicula</i> (Oostingh, 1925) | Visakhapatnam |
| 10. <i>Rhinoclavis (Rhinoclavis) fasciata</i>
(Bruguiere, 1792) | Coromandal Coast,
Andamans |

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Family DIALIDAE

Shell is small, smooth and without anterior or posterior canal. Protoconch is smooth. A chitinous operculum is present.

Generally found attached to weeds near coral reefs.

Diala semistriata (Philippi, 1849)

(Pl. 23, fig. 6)

Shell minute, up to 2 mm in height, thin, narrowly elongate and glossy, sutures channeled, protoconch consists of 1 ½ whorls and smooth, surface smooth except for fine spiral threads at the base, columella straight, umbilicus absent, cream coloured with brown and white spiral band below sutures.

India : Andamans. Indo-West Pacific.

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Family POTAMIDIDAE

Horn Shells

Shell is small to large, up to 140 mm in height, long, turreted and usually thick. The number of whorls varies from 10 to 16 with a high spire. Aperture is rounded or oval with a rudimentary anterior siphonal canal and in some a posterior siphonal notch, outer lip usually is thickened and grows beyond the columellar base. Surface of the shell is generally sculptured with spiral cords and axial ribs that are often broken into nodules. Operculum is horny, thin and pauci-to multi-spiral. Nucleus is generally in the centre.

Head is broad with a prominent snout, which is wrinkled and highly contractile. A pair of tentacles projects from the neck, with eyes situated at their outer bases. Tentacles may be spotted or banded with red and black. Foot is massive, subcircular anteriorly and obtuse posteriorly. Mantle cavity is very deep and consists of an elongate and prominent osphradium and a well-developed monopectinate ctenidium occupying a considerable portion of the mantle cavity. Radula is taenioglossate and the stomach is quite large. Sexes are separate. Male does not possess a copulatory organ. A spermatophore is formed to store the sperms and to transfer them into the female. Pallial gonoducts are open. Eggs are laid in the form of mucus strings as long coils.

Potamidids are detritus feeders and are abundantly common in estuaries, backwaters and mangroves. Some can live out of water for days.

The family is divided into two subfamilies, namely Potamidinae and Batillariinae, which differ in their shell and radular teeth characters.

Subfamily POTAMIDINAE

Cerithidea alata (Philippi, 1847)

(Pl. 22, fig. 1)

Shell small, up to 25 mm length, thick, whorls 12 to 13, sutures distinct, traversed by a thread. Aperture elongate ovate, outer lip and inner lip meet posteriorly at a point beyond the shell plane, siphonal sinus hollow and short, outer lip reflects over the sinus. Sculptured with rounded, somewhat rectangular, close-set axial nodules, three on each whorl, on the body whorl the nodules coalesce together forming broad, flattened raised interspaces separated by shallow grooves. Colour grayish brown, interior of aperture, columella and outer lip white.

India : West Bengal : Sunderbans; Andhra Pradesh, Tamil Nadu, Andamans. Indian Ocean.

The species bears resemblance to *Cerithidea cingulata* in shell characters but can be easily differentiated by its typically detached aperture and sculpture.

***Cerithidea (Cerithideopsis) cingulata* (Gmelin, 1791)**

(Pl. 22, fig. 2)

Shell moderately large, up to 50 mm in height, elongate and thick, 13-15 flat-sided whorls separated by shallow sutures. Aperture oval, columella almost straight, outer lip thick and expanded broadly, anterior siphonal canal distinct and short with a varice-like bulge and blunt rib above. Sculptured with prominent spiral ridges crossed by equally strong axial ribs forming rows of regular granular nodules. Colour dark brown, often with a whitish band above the suture, nodules dirty white, interstices brown, interior of aperture white, lined with brown. Operculum spherical with a central nucleus.

India : Very common in the estuaries and backwaters along East and West Coasts. Population density can be as high as 12000/m². Indo-West Pacific, common.

The species prefers submersion and periodical exposure. Eggs are laid in capsules that form a mass of filamentous threads. It has a planktotrophic veliger larva in its development.

Synonym : *Cerithidea fluviatilis* (Potiezeet Michaud).

***Cerithidea (Cerithidea) obtusa* (Lamarck, 1822)**

(Pl. 22, fig. 5, 6)

Shell larger than that of *C. (C.) cingulata*, up to 60 mm in height, elongate and lightweight, whorls 7 to 8, apex usually eroded (decollated), body whorl as broad as high. Aperture strongly spherical and wide, with expanded and recurved outer lip, columella weak, basal end slightly twisted, a short siphonal canal. Sculptured with about 6 to 7 spiral ridges and about 8 to 10 axial ribs on each whorl. Colour pale pinkish, lip and columella white, aperture light brown and with dark brown bands. Operculum circular with central nucleus and concentric growth lines, dark brown. Head bears a pair of tentacles with alternating broad black and red bands.

India : West Bengal : Sunderbans; Orissa : Mahanadi Estuary; Andhra Pradesh : Godavary Estuary; Tamil Nadu : Pitchavaram Mangrove; Nicobars ? mangrove ecosystem. Indo-West Pacific.

The snail occurs near high tide mark and avoids submersion. During high tide the snail climbs on to the plants and when the water recedes it crawls down to the mud flat. This species is not as common as the preceding species.

***Telescopium telescopium* (Linnaeus, 1758)**

(Pl. 22, fig. 3)

Shell very large, up to 120 mm in height, shell elevated and strongly conical, heavy and thick, with about 14 to 16 whorls, sutures not distinct. Aperture small and rounded, columella

solid, strongly twisted and channeled, outer lip thickened, extended anteriorly as a flare over siphonal canal. Sculptured with four unequal, flat spiral ridges on each whorl, last whorl rounded at base with one large and many small cords. Colour dark brown or black, interior shiny blue-black, columella mauve-brown.

India : Gujarat, Kerala, Tamil Nadu, Pondicherry, Andhra Pradesh, Orissa, West Bengal, common in estuaries and mud flats. Indian Ocean and Australia.

The species is equally at ease with submersion and exposure. The population density along East Coast of India is moderate. Eggs are laid in filamentous mass.

Terebralia palustris (Linnaeus 1767)

(Pl. 22, fig. 4)

Shell very large, up to 130 mm in length, elongate, with about 14 flat-sided whorls. Aperture with thickened lips, outer lip arched and curved over short siphonal canal, columella with callus deposit, posteriorly thickened with rib-like callus, outer lip also with callus, interior of aperture obsoletely grooved. Sculptured with deeply incised regularly spaced spiral grooves separated by broad and flat interspaces, straight edged and flattened transpiral ribs in juveniles, a humped varix on the body whorl anteriorly opposite columella. Colour dark brown, interior purple brown, lip fawn coloured and columella chocolate brown with white shining area posteriorly.

India : Lakshadweep, Tamil Nadu : Kundugal Point, Krusadai Island; Andhra Pradesh : Godavary and Krishna Estuaries; Orissa, Nicobars, mangroves and backwaters. Indo-Pacific, widely distributed in the tropical Pacific.

The species occurs along with *Telescopium telescopium* but is not as common as that. So far it was not reported from Sunderban mangroves (West Bengal) and Pitchavaram Mangroves (Tamil Nadu).

Synonym : *Pyrasmus palustris* of authors.

Pirenella layardi bombayana Sowerby

(Pl. 22, fig. 7, 8)

Shell small, up to 15 mm in length, slender with 11 to 12 rounded whorls, sutures distinct. Aperture ovate, outer lip simple and thin, columella arched with a little broad and reflected callus anteriorly, no siphonal canal. Sculptured with three spiral cords on each whorl, the subsutural cord broken into round nodules, body whorl with three radiating cords at the base. Colour dark brown, columella and aperture yellowish brown.

India : Maharashtra : Bombay. Indian Ocean.

Subfamily BATILLARIINAE

Batillaria angulifera (Sowerby, 1866)

(Pl. 22, fig. 9, 10)

Shell small, up to 25 mm in length, slender and turreted, with distinct sutures, body whorl slightly angular in the middle. Aperture obliquely subtrigonal, slightly produced anteriorly with a shallow, truncated siphonal canal. Sculptured with spiral ribs thrown into tubercles, more or less evenly spaced giving a plaited appearance, tubercles weak at the base of the body whorl below the angle, often a varicose elevation opposite the aperture. Colour dull brown, with dark and light brown spiral bands, aperture dull white.

India : Tamil Nadu. Elsewhere : Australia.

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Family FOSSARIIDAE

Shell is very small in size, usually not more than 15 mm in length, subglobose, turbate, with moderately high spire and a prominent, conical protoconch. Aperture is rounded, oblique and entire, outer lip simple and occasionally undulate, columellar margin oblique to straight. Umbilicus is present. Surface is sculptured with spiral cords crossed by transverse costulae. Operculum is thin, corneous, paucispiral with an excentric nucleus.

There is a pair of elongate, filiform cephalic tentacles, which bear eyes at their outer bases. Foot is rounded at both ends. Mantle edge is without processes. Radula is taenioglossate (2-1-1-1-2). Sexes are separate.

It is a poorly known family with six genera and about two-dozen species. In India the monotypic genus *Chilkaia* is endemic to Chilka Lake.

Chilkaia imitatrix Preston, 1915

(Pl. 23, fig. 5)

Shell minute, up to 2.5 mm in height, oblong ovate, whorls 3, suture impressed, the body whorl shouldered in the infrasutural region. Aperture oblique and rather elongately ovate, outer lip arcuate, rather dilated below. Columella descending in a curve, with a thick parietal callus posteriorly uniting it with the outer lip, umbilicus very narrow. Sculptured with fine and wavy spiral striae crossed by distantly placed oblique transverse plications; covered with light reddish periostracum, aperture white.

India : Orissa : Chilka Lake, endemic, rare.

Family TURRITELLIDAE

Screw Shells

Shell is small to large, up to 100 mm long and attenuate with numerous whorls. Aperture is proportionately small, rounded or angled at the top. Outer lip is thin with a convex outer margin. There is no umbilicus. Sculpture consists of spiral striations or ridges. Operculum is chitinous, circular, thin and multispiral with a central nucleus.

Head is large and bears long tentacles having eyes at their outer bases. Foot is short, truncate anteriorly and narrow posteriorly, with a groove on the ventral side. It possesses a pedal gland at the posterior end. Mantle margin is fringed and has a siphonal fold on the right side. Mantle cavity consists of a monopectinate ctenidium and a string-like osphradium. Radula is taenioglossate, 3-1-1-1-3. Digestive system contains small salivary glands, long and narrow oesophagus and a large two-chambered stomach. Sexes are separate. Male is without a penis. Some deposit eggs in stalked capsules, while some brood the young within the oviduct. Veliger larva may be of short duration.

Majority of the species prefer muddy sands of tropical waters. These are detritus feeders and occur from intertidal to offshore, mostly beyond the low tide line. It is a large family consisting of five subfamilies embracing 18 genera and an estimated 150 species. In India two genera, *Turritella* and *Haustator*, belonging to the subfamily Turritellinae are reported. These are mainly distributed along the continental shores.

***Turritella attenuata* Reeve, 1849**

(Pl. 23, fig. 1)

Shell large, up to 96 mm in height, elongate and attenuate with 15 to 16 rounded whorls. Aperture sinuate. Sculptured with raised spiral striations of equal size on earlier whorls, on later whorls, from 10th or 12th onwards, middle striation becoming stronger and others getting gradually weak and obsolete. Whorls strongly keeled in the middle, with sloping upper part and curved lower part. Coloured light brownish or pinkish, upper part of whorls tinged with blue.

India : West Bengal : Digha; Orissa : Puri; Tamil Nadu : Madras to Tranquebar; Pondicherry, common. Elsewhere : Indonesia.

***Turritella columnaris* Kiener, 1840**

(Pl. 23, fig. 2, 3)

Shell large, up to 80 mm in height, elongate, lanceolately turreted, with about 30 whorls, suture excavated and not much inflated, sometimes flattened in the middle, base strongly angulated. Sculptured with two strong spiral striations on the earlier whorls, others obsoletely

granulated, more or less with about 10 uniform spiral ridges. Coloured yellowish brown with vertical brown stripes and blotches.

India : Orissa; Tamil Nadu : Madras, Adiramapatnam; Pondicherry, not common. Indian Ocean.

Turritella duplicata (Linnaeus, 1758)

(Pl. 23, fig. 7-9)

Shell large, up to 107 mm in height, about 18-20 whorls, the earlier whorls convex with many fine spiral ridges, on other whorls two sharp ridges in the middle, after the first six whorls the central ridge becomes elevated into a strong keel, other spiral ridges become obsolete or disappear, after about ten whorls another elevated ridge begins to appear and on the penultimate and body whorl both of these become less conspicuous. The whorls at both end rounded and those in the middle sharply angular. The upper half of each whorl medium dark brown and the lower pale cream brown.

India : Gujarat : Gulf of Kachchh; Maharashtra, Tamil Nadu, Pondicherry, Orissa, common in subtidal sand. Indo-Pacific.

Synonym : *Turritella acutangula* (Linnaeus, 1758).

Haustator trisulcata Lamarck, 1822

(Pl. 23, fig. 4)

Shell of moderate size, up to 48 mm in height, acuminate turreted. Aperture subquadrangular, outer lip sinuous. Sculptured with three spiral ridges, intermediate grooves concave and spirally striated. Coloured brown, often with chestnut to light brown spiral or transpiral markings, apical whorls tinged with violet or blue.

India : Tamil Nadu : Gulf of Mannar (Mandapam Camp), common. Indian Ocean : Red Sea to Mergui Archipelago.

Family SILIQUARIIDAE

Slit-worm Shells

It is a monogeneric family. Shell bears some resemblance to that of a vermetid. Early whorls are closely coiled and the later whorls grow haphazardly. A narrow slit or a series of holes runs the length of the shell except at the flattened apex. These occur in clusters or solitarily. Little is known about their biology and distribution.

The genus is represented by four species, mainly from Orissa.

Tenagodus anguina (Linnaeus, 1758)

(Pl. 24, fig. 1)

Shell thick, irregularly twisted and sculptured with spinose spiral ribs. Colour light brown.

India : Orissa (55-70 m), found embedded in the sponge *Spongorites topsenti* Dendy, Andamans. Indo-Pacific.

Tenagodus cumingi Moersch, 1860

(Pl. 24, fig. 6-8)

Shell narrow, elongate, apex coiled, sculptured with fine spiral ridges except on either side of siphonal slit.

India : Orissa, on the sponge *Racodiscus scraptellifera* var. *siproglyphi* Annandale. Elsewhere : Philippines, Japan.

Tenagodus tostus Moersch, 1860

(Pl. 24, fig. 2, 3)

It resembles *T. cumingi* in shell characters but can be distinguished by its larger diameter, and by the presence of denticulate ridge on either side of the slit.

India : Orissa. Elsewhere : Philippines.

Tenagodus trochlearis Moersch, 1860

(Pl. 24, fig. 4, 5)

Early part of the shell compactly coiled like a disc, tube thick with fine spiral striations, scabrous, prominent towards the posterior part.

India : Orissa. Elsewhere : Philippines.

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Family VERMETIDAE

Worm Shells

It is a most puzzling group among gastropods and difficult to identify on the basis of beach-worn specimens. Shell is an irregularly coiled long tube unlike in other gastropods, and varies in size, which may reach a length of 100 mm and diameter 2 to 15 mm. Apex is evenly and spirally coiled. Protoconch consists of 2 to 4 whorls. Adult whorls are coiled at a right angle to the nuclear whorls. Surface consists of irregular cords. Operculum, when present is chitinous, spiral and centrally thickened.

Shell is often confused with that of a tube-building annelid worm. But the two can be easily differentiated. The vermetid shell has three layers and the interior glossy, a tightly and spirally coiled embryonic shell, whereas the annelid tube has a two-layered shell, dull interior and no embryonic shell. In the latter the shell begins with a tubular chamber.

Head bears a pair of stout tentacles. Foot is reduced and has a glandular sole. Mantle cavity consists of a ctenidium that bears triangular leaves and often cirri. A pair of pedal tentacles is present. Proboscis is short. Radula is taenioglossate.

Sexes are separate. Male has no penis but there are pelagic spermatophores. Female is ovoviviparous or viviparous and possesses an incubatory pouch.

Worm shells are abundant in the intertidal zone and live attached to corals, rocks or other shells. These are either solitary or colonial.

The family includes four genera; only the genera *Serpulorbis* and *Vermetus* are reported from India.

Serpulorbis sp.

Shell is yellowish brown. It is irregularly coiled. Surface is sculptured with spiral ribs. Aperture circular. There is a single box in the National Zoological Collections labeled as Vermetidae. It has not been possible to correctly identify shells up to species level.

India : Andamans : Peel Island. It is found attached to the coral, *Pachyseris speciosa* (Dana).

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Family STROMBIDAE

Winged Shells or Conch Shells

Shell is solid and small to large. It exhibits different shapes but has an enlarged body whorl and a low conical to turreiform spire. Aperture is long and narrow, with anterior and posterior canals. The most distinguishing features of the shell are the development of a large, flaring and thickened outer lip and the presence of a U-shaped notch or indentation on the edge of the lip near the end. It is referred as a 'stromboid notch' and facilitates the protrusion of right eye. Outer lip may be digitate and some times with inner plications. Umbilicus is lacking. Shell surface may be smooth or may have axial and spiral threads, and varices. Operculum is long, sharp, strong, chitinous and claw-like with a terminal nucleus. It assists in the leaping and jumping locomotion and serves as a defensive weapon to ward off predators.

Head bears long and muscular eye peduncles, each one of which gives rise to a small short tentacle a little below its distal end. Eyes are well developed and have colourful irises. Foot is narrow, very muscular and is divided into an anterior prepodial sole and an elongate posterior metapodium bearing the operculum. Mantle bears pallial tentacles and its cavity consists of a long narrow osphradium. Proboscis is long and thin.

Radula is taenioglossate and short. Digestive system consists of long and thin salivary glands, and a crystalline style in the stomach.

Sexes are separate and sexually dimorphic, the shell in males being slightly smaller than in the females and differently sculptured. Male possesses a long, open-grooved penis. Female has an open gonoduct. The animals congregate at the time of spawning. Eggs are laid in long, jelly-like coiled tube. Larva is planktotrophic.

Winged shells are usually shallow water inhabitants common in the intertidal zone or beyond the low water limit associated with algal-rich coral reefs. They may occur as epifauna on the coral boulders or burrow into the sand in the reef area. They are either herbivores or detritus feeders.

The family contains six genera and an estimated 100 species distributed in the tropical and semi-tropical seas. As many as five genera and twenty species are so far reported from Indian seas.

Strombus (Laevistrombus) canarium Linnaeus, 1758

(Pl. 25, fig. 1)

Shell large, up to 70 mm in height, solid, spire may be short and smooth or high with angular whorls, body whorl with the expanded outer lip proportionately broader, almost as broad as high. Edge of winged outer lip rounded, stands at a considerable distance from the columella,

weak stromboid notch, very short siphonal canal. Columella with glazed callus. Surface smooth, apical whorls spirally grooved, apex with whitish remnants of varices, body whorl striated at the base, smoothly rounded or with faint ridges, surface with close-set, wavy, transpiral orange-red lines, interior and columella white, parietal wall may often be metallic.

India : Andhra Pradesh, Tamil Nadu : Gulf of Mannar, Tuticorin; Andamans. India to Japan, Australia and Melanesia.

It occurs on sandy mud from low tide line to a depth of about 6 m.

***Strombus (Canarium) erythrinus erythrinus* Dillwyn, 1817**

(Pl. 25, fig. 2)

Shell of medium size, up to 45 mm in height, narrowly elongate. Aperture small, outer lip slightly expanded, thickened, lirate internally, columella with callus and plaits at each end, stromboid notch weak, siphonal canal short. Sculptured with axial riblets which form small rounded knobs at the slightly angular mid-sutural periphery, shoulder of the body whorl rounded and with about 9 to 11 small, axially lengthened knobs, apertural varix swollen and crossed by numerous spiral threads. Colour usually cream and clouded with brown, often with two chocolate bands on the middle of the body whorl; inside of outer lip, inner half and base of columella rich dark purple brown, often a white band along the inner edge of the outer lip.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Strombus (Canarium) labiatus labiatus* (Roeding, 1798)**

(Pl. 25, fig. 6)

Shell of medium size, up to 35 mm in height, solid and elongate, higher than broad. Outer lip not much expanded and a poorly developed stromboid notch, columella narrow, glossy, weakly lirate along its entire length, siphonal canal truncate below. Sculptured with strong axial ribs, on the shoulder with 2 or 3 knobs. Colour variable, may be brown or gray with yellowish maculations, broken bands and axial streaks, columella orange to yellowish orange with darker brownish orange stripes.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Strombus (Canarium) mutabilis* Swainson, 1821**

(Pl. 25, fig. 10)

Shell small, up to 26 mm in height, solid, smooth, quadrate in shape, spire whorls shouldered. Aperture oblong, columella enameled, outer lip thickened, with a short blunt projection at the posterior end, shallow stromboid notch, siphonal canal short and slightly recurved, columella and aperture lirate. Sculptured with rounded, blunt axial ribs becoming heavy knobs, three to

four at the shoulder on the dorsal side of the body whorl, faint spiral cords on base and near the lip. Colour cream mottled and spotted in light or dark browns in axial streaks and often a few spiral bands on the body whorl, columella and outer lip white or pink.

India : Tamil Nadu : Tuticorin; Andaman and Nicobar Islands. Indo-Pacific, not common. Intertidal, in coral sand or sandy mud.

Strombus (Canarium) marginatus marginatus Linnaeus, 1758

(Pl. 25, fig. 3)

Shell of medium size, up to 46 mm in height, ovately conical, spire short and depressed, apex sharp. Aperture narrow, columella polished and with white callus, faintly wrinkled below, outer lip thickened, its sharp edge ends posteriorly on keel of penultimate whorl, posterior canal arching on to spire, siphonal canal short, stromboid notch shallow. Spire whorls sculptured with varices or axial ribs and sharply angular shoulder, last two whorls without any ribs but only a nodulose keel on the shoulder, body whorl with deeply incised sharp lines at its base. Colour white, maculated with dark or light brown, four white broken spiral bands on body whorl, also white, inside of outer lip lirate, white, aperture interior also white.

India : Tamil Nadu, Andamans. Indian Ocean.

Strombus (Canarium) marginatus succinctus Linnaeus, 1767

(Pl. 25, fig. 11)

Shell of medium size, up to 34 mm in height, spire fairly high and acuminate. Aperture elongate, white and spirally striated, outer lip sinuate and curled inward, posterior canal extends straight up and adheres to 2 or 3 spiral whorls. Sculpture consists of numerous axial riblets on apical whorls, with varices on post nuclear whorls, a single, rounded and distinct knob on the shoulder of the body whorl dorsally. Colour yellowish-brown with fine reticulated arrow shaped narrow, white spiral bands.

India : Tamil Nadu : Madras, Gulf of Mannar; Andamans, rare, restricted to Bay of Bengal.

Strombus (Doxander) listeri T. Gray, 1852

(Pl. 26, fig. 3, 4)

Shell large, up to 100 mm in height, rather thin but strong, with a high, pointed spire, long and narrow body whorl. Outer lip a little quadrangulately expanded with the thickened edge almost parallel to the columella, posteriorly forms a round ended projection extending almost on level to the suture above the penultimate whorl; anterior canal well developed, stromboid notch very deep and U-shaped. Sculptured with many axial ribs and fine spiral cords in between on the early whorls, lower whorls rather angulated at the shoulder and smooth for the major part

with spiral striae at the base dorsally. Colour white and brown covered with chestnut undulating axial stripes, body whorl with four spiral rows of small, white, chevron-shaped marks, aperture white, columella and interior tinged with brown.

India : West Bengal : Sand Heads; Andhra Pradesh : Visakhapatnam; Pondicherry. Gulf of Oman to Myanmar and Thailand.

***Strombus (Lentigo) lentiginosus* Linnaeus, 1758**

(Pl. 26, fig. 1, 2)

Shell large, up to 90 mm in height, solid and heavy, spire short and pointed. Aperture narrowly elongate, columella smooth with glazed parietal callus, extending almost as far as the apex, swollen and projecting at the base, outer lip slightly flared, prominently thickened opposite the callus, posterior canal distinct, curved and extended to join spire on suture above antepenultimate whorl, stromboid notch deep, anterior canal short and recurved a little upward to the right. Sculptured with spiral striae on the early whorls, axial ribs nodulose on shoulder, body whorl with five rows of much smaller nodules, three other coarse ridges without nodules, coarse striae at base. Colour white, heavily speckled with greenish gray or grayish brown, interior and columella pink brown, parietal area a little metallic with zigzag pattern of soft browns.

India : Andamans. Indo-Pacific.

***Strombus (Gibberulus) gibberulus gibberulus* Linnaeus, 1758**

(Pl. 26, fig. 5, 6)

Shell moderately large, up to 50 mm in height, solid, fusiform, spire moderately raised, attenuated towards the base with whorls distorted, penultimate whorl expanded bulging over suture dorsally on the body whorl. Columella smooth, white, flushed with violet, outer lip expanded posteriorly reaches the body whorl well below suture, stromboid notch moderately deep, anterior canal long and somewhat recurved, posterior canal short and dark brown at its base. Sculptured with spiral cords on the spire whorls, body whorl smooth except for spiral striae at the base near the columella. Colour white, conspicuously marked with broken light brown axial lines with narrow dark tan spiral bands, inner edge of outer lip with a purple axial band, columella pinky white, interior white with mauve tinge.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar (Kundugal Point, Krusadai); Andaman and Nicobar Islands. Indian Ocean.

***Lambis (Lambis) lambis* (Linnaeus, 1758)**

(Pl. 27, fig. 3–5)

Shell very large, up to 280 mm (including digitate processes), solid, heavy, covered with thin, translucent tan periostracum, spire acuminate with about eight whorls. Aperture narrow,

smooth, polished, small ridge on columella and on the inside of outer lip posteriorly. Outer lip **flare widely**, extends over up to apex and its edge forms six slender digitate processes which **may be short or long**, anterior canal moderately long and slightly twisted to the left, very deep and wide stromboid notch, parietal callus covers half of body whorl and up to the apex, but not **contiguous** with it. Sculptured with spiral and axial striae on the spire, small knobs on sharp **angular** shoulders, body whorl with fine blunt knobs on the shoulder. Colour creamy white **heavily mottled** with brown, columella, parietal area and interior flesh-pink.

Shells exhibit sexual dimorphism. In male the shell is smaller and the anterior three processes **are quite short** and only slightly recurved, where as in female it is larger, and the digitations are **longer**, almost twice the length and curved up, and also with a bilobed knob at the shoulder on **the dorsum** and with wide gap between the two posterior most digitations.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, common. **Indo-Pacific**, widely distributed from East Africa to Micronesia and Melanesia.

Abundant on sandy substrata in the weedy coral reef-flats.

Lambis (Lambis) crocata crocata (Link, 1807)

(Pl. 27, fig. 8, 9)

Shell large, up to 100 mm in height, spire moderate with about twelve whorls. Aperture **elongate** and smooth, outer lip with six slender digitations, stromboid notch wide and deep, **anterior canal** long and gracefully curved. Sculptured with spiral and axial cords on the spire, a row of presutural beads, body whorl with three spiral rows of knobs, top spiral row of four **knobs**, the last two large, two other rows below with four to six smaller knobs. Colour creamy-white maculated with brown, aperture solid-orange.

India : Tamil Nadu : Gulf of Mannar; Andamans, rare. Indo-Pacific, moderately common in **the reef ecosystem**.

Lambis (Millepes) scorpius indomaris Abbott, 1961

(Pl. 27, fig. 6, 7)

Shell large, up to 100 mm in height, spire short. Aperture very narrow, elongate, with well-developed spiral lirae, outer lip curves round posteriorly to cover half of spire and forms rounded, **triangular flange** on far side of first projection, with six digitations, three posterior digitations **long**, three opposite the columella short and recurved towards posterior, stromboid notch deep with **scalloped edge**, anterior canal long, curved and sealed distally. Sculptured with spiral cords and small knobs on angular shoulder, body whorl with four rows of knobs, upper most with five **large knobs** and the lower three with smaller knobs. Colour white and pale gray with brown

spots, aperture interior and interstices purple brown, aperture and columella with strong white lirations, outer lip inner edge pink.

India : Andamans, not common. Western and Central Indian Ocean, coral reefs.

***Lambis (Harpago) chiragra chiragra* (Linnaeus, 1758)**

(Pl. 27, fig. 1)

Shell very large, up to 200 mm in height, spire low, with nine angulated whorls. Aperture very narrow and small, outer lip curved posteriorly over the top of columella covering almost half of the spire, with six digitate processes pointing posteriorly, stromboid notch deep, columella and inner edge of outer lip lirate, parietal area wide. Sculptured with spiral striae on the spire, becoming coarse on body whorl, four rows of knobs on the body whorl, four large knobs on the shoulder, the last two largest and almost fused, four other rows of knobs, the lowest bearing weak knobs. Colour white, mottled with brown, outer lip, columella and aperture dirty brown.

Male and female shells are different. The former has smaller shells, with strong white spiral lirae over a purple coloured columella, five knobs on the body whorl. Female has a bigger shell, whitish rosy aperture and smooth white columella.

India : Andamans and Great Nicobar Island. Eastern Indian Ocean to Eastern Polynesia.

***Terebellum terebellum* (Linnaeus, 1758)**

(Pl. 28, fig. 11, 12)

Shell moderately large, up to 55 mm in height, narrowly elongate and smooth. Aperture narrow and widening at the bottom, columella almost straight and smooth, extending below the level of outer lip, slightly thickened outer lip, stromboid notch absent. Shell surface without sculpture, colour cream with rows of brown dots often arranged in bands.

India : Andamans, rare. Indo-Pacific, East Africa to Japan, Australia and Samoa.

***Rimella (Varicospira) cancellata* Linnaeus, 1758**

(Fig. 26, Pl. 28, fig. 14)

Shell small, up to 20 mm in height, solid, fusiform, spire acuminate, outer lip thickened, crenulated, flanked by a deep furrow, extends towards apex covering two to three spire whorls, columella with callus, extends over whole length of the body whorl and with the outer lip forms a long anal canal, siphonal canal short, aperture and lip lirate. Sculptured with axial ribs connected by pitted, spiral grooves giving it cancellate appearance and randomly placed varices. Pale yellowish brown, outer lip edge and varices red brown, columella and aperture white.

India : Andhra Pradesh : Visakhapatnam, Andamans, very rare. Sri Lanka to Amboina and Philippines.



Fig. 26. *Rimella cancellata* with animal. Visakhapatnam

Tibia delicatula (Nevill, 1881)

(Pl. 25, fig. 8)

Shell moderately large, up to 67 mm in height, more delicate and translucent than in other species, whorls ten, moderately convex. Aperture oval, not very large, anterior canal short and pointed, posterior canal a small groove, columella with thick callus, smooth, outer lip thickened with four to five short digitate processes, protoconch smooth, post nuclear whorls with inconspicuous regular striations, which become obsolete on later whorls. Colour pale ochre brown, body whorl with four to five narrow white bands, each one terminating at the digitations on the outer lip, other whorls with a single white band in the middle.

India : Orissa, Andhra Pradesh : Krishna Delta; Pondicherry. Indian Ocean.

It occurs in the infralittoral region of the Bay of Bengal at and near the 100-fathom contour, Red Sea and Arabian Sea between 175 fms and 400 fms.

Tibia fusus (Linnaeus, 1758)

(Pl. 25, fig. 4)

Shell very large, up to 150 mm in height, solid and stout, fusiformly turreted, whorls 16-20, spire acuminate. Aperture wide and elongate, columella arched, with callus, outer lip slightly expanded, bearing 4 to 6 very short blunt digitations on its lower half, anterior canal long and slightly curved. Sculptured with axial ribs on the early whorls.

India : Gujarat : Okha (18 m); Maharashtra : Bombay (18- 27 m); Kerala (82 m); Tamil Nadu : Rameswaram; Pondicherry. Red Sea and Persian Gulf to Southeast Coast of India.

It is common and prefers muddy bottom.

***Tibia powisii* (Petit, 1842)**

(Pl. 28, fig. 13)

Shell moderately large, up to 60 mm in height, elongately fusiform, solid, whorls 12 to 13, flatly rounded, spire acuminate. Columella with callus deposit, posterior canal very short and curved, with dark brown tip, anterior canal rather short and slender, outer lip thickened, with five digitations, posterior most broader and blunt, separated by a wide gap from the anterior four equidistantly arranged projections. First four or five whorls smooth, the rest closely spirally ridged, the interstices or grooves densely cancellated with striae. Colour straw-tainted brown.

India : Andamans (112 to 183 m). Elsewhere : China, East Savu Sea and north coast of Sumbawa, moderately common.

***Tibia insulaechorab curta* (Souerby, 1842)**

(Pl. 25, fig. 5, 9)

Shell very large, up to 160 mm in height, fusiform and slender, whorls 15 to 16, upper part of each whorl concavely slanting, then rounded. Aperture rather small, columella arched and with callus, posterior canal short and curved, flanked by parietal columellar ridge, anterior canal very long and slender, outer lip with six digitations, posterior most of peculiar shape not projecting and bordering the posterior canal, the one below it grooved at the base bearing a tooth like swelling. First eight whorls with very closely set fine axial ribs, crossed by faint spiral striae giving an indication of beaded appearance, the rest of the whorls smooth, body-whorl with spiral striae at its base. Colour cream or pale brown, columella fulvous brown, outer lip dark purple brown between the digitations.

India : Maharashtra : Bombay; Nicobars, very rare. Indo-Pacific, Red Sea to China Sea.

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Family HIPPONICIDAE

Shell is small, limpet-like and cap-shaped. Protoconch is neritoid and globose. Apex is a little towards posterior end and pointed backwards. Aperture is irregularly rounded depending on the substratum to which the snail attaches. There is a horseshoe shaped and anteriorly open muscular scar on the interior. Surface is generally sculptured with radial riblets or striae. There is no operculum.

Head bears a pair of long tentacles with sessile eyes at their outer bases. Foot secretes a shell ventrally, which cements the animal to the substratum. Mantle cavity consists of a simple ctenidium and osphradium. There is a ventrally incised proboscis. Radula is taenioglossate. Digestive system consists of a simple and cylindrical salivary gland and a large stomach. There are no oesophageal pouches. These are protandrous hermaphrodites and have a short-lived planktonic larval stage. In some, the females carry small males.

These are sedentary forms and live attached by fixing themselves to the substrate with the help of a ventral calcareous plate. These occur in the crevices of rocks, or on shells or corals etc. These are either ciliary filter feeders or detritus feeders. Some of the species are parasitic on gastropods.

The family includes about six recognised genera out of which two namely, *Hipponyx* Defrance, 1819 and *Cheilea* Modeer, 1793 are represented in India.

Hipponyx acuta Quoy and Gaimard, 1834

(Pl. 29, fig. 1, 2)

Shell small, up to 20 mm in height and 25 mm in diameter, almost round in shape, solid, cap-shaped, apex recurved backwards. Surface sculptured with coarse, irregular, flattened radial ribs indenting the margin. Colour dull gray, internally pale pinkish with yellowish muscle scar.

India : Andamans, rare. Indian Ocean.

Cheilea equestris (Linnaeus, 1758)

(Pl. 28, fig. 7, 8)

Shell small, up to 15 mm in height and 21 mm in diameter, shell thick, bowl-shaped, apex excentric with beak-like prominence directed posteriorly. Aperture more or less circular, funnel-shaped calcareous internal septum freely suspended from just below the apex. Surface sculptured with raised close-set, sharp radiating ridges, interstices with fine striae, lacks the coarse concentric corrugations.

India : Tamil Nadu : Gulf of Mannar (Krusadai Island); Andamans. Indo-West Pacific.

Cheilea undulata (Roeding, 1798)

(Pl. 28, fig. 3, 4)

Shell larger than in the preceding species, up to 22 mm in height and 40 mm in diameter, irregularly ovate, not so conical as in *C. equestris*, apex subcentral and blunt, internal septum comparatively small. Surface striated giving wrinkled appearance because of the presence of widely separated spiral grooves.

India : Tamil Nadu : Gulf of Mannar; Andamans. Elsewhere : Philippines.

Family VANIKORIDAE

Shell usually is small, not more than 25 mm in height, globose and not so thick. Protoconch is small, conical and smooth. Body whorl is large, inflated and rounded with a wide and somewhat oblique aperture. Columella is arcuate and without any callous deposit. Outer lip is not much thickened and discontinuous. An umbilicus is usually present. Surface is sculptured with fine spiral and axial striae. The operculum is thin, chitinous and paucispiral with an excentric nucleus.

Head has a pair of well-developed tentacles with sessile eyes at their outer bases. Foot is well developed. Mantle has smooth margin and encloses a large and broad mantle cavity that contains an extensive ctenidium bearing triangular filaments. There is a well-developed proboscis with a bilobed tip.

Radula is short, wide and taenioglossate. Alimentary system consists of a short and thick salivary gland, narrow oesophagus, large and partitioned stomach, and long coiled intestine. Sexes are separate. Male has a penis and closed sperm duct.

The family is monogeneric with a few species in tropical and subtropical seas. These generally occur under coral, rubble or boulders near reef areas.

Vanikoro cancellata (Lamarck, 1822)

(Pl. 29, fig. 5, 6)

Shell small, up to 23 mm in height and 20 mm in diameter, thin, body whorl inflated, spire depressed with the apex slightly exerted above the level of the body whorl. Aperture very wide, almost rounded, outer lip extends over to the body whorl above the level of the slightly arched columella, umbilicus may be narrow and deep or often closed. Sculptured with raised, regular axial ribs crossed over by narrow primary spiral cords and three to four very fine secondary spiral threads in between two primary cords. Colour creamish, aperture and columella white.

India : Lakshadweep, Tamil Nadu : Kanya Kumari; Orissa, Andamans, not common. Indo-West Pacific.

Vanikoro plicata (Recluz, 1844)

(Pl. 29, fig. 3, 4)

Shell small, up to 13 mm in height and 11 mm in diameter, thin, globose ovate, spire short but elevated protruding above the body whorl, protoconch with two smooth whorls. Aperture semicircular, columella straight, umbilicus broad and deep. Sculptured with very strong, widely spaced, sharp and raised axial ribs, interspaces with close-set fine threads. Colour dull white.

India : Andamans, rare. Elsewhere : Gulf of Arabia.

Vanikoro rosea (Recluz, 1844)

(Pl. 29, fig. 7, 8)

Shell small, up to 10 mm in height, thin, spire short but raises above the level of the body whorl, suture distinct, body whorl angulated at the shoulder. Aperture large, semicircular, outer lip thin and not extending above the level of the straight columella, umbilicus broad and deep. Sculptured with crowded spiral threads on the body whorl and spire whorls, on the latter fine axial threads cross the spiral threads. Colour dull yellowish, aperture white.

India : Maharashtra : Bombay; Andamans, not common. Indo-Pacific.

The shell of this species is somewhat similar to that of *V. gueriniana* (Recluz) but can be differentiated by its sculpture.

Family CREPIDULIDAE (Calyptraeidae)

Slipper Limpets, Cup and Saucer Limpets

Shell is small to medium in size reaching up to 30 mm in diameter. It is limpet-like and cap-shaped to conical. Shape of the shell is often variable depending on the nature of substratum to which it attaches. Apex is marginal or central with a spiral coil. Aperture is large occupying major part of the shell ventrally. A characteristic feature of the family is the presence of an internal shelf, which extends from the columella to cover partly or major part of the aperture. Muscle scar is oval to horseshoe shaped. Surface sculpture consists of radiating ribs and concentric cords. Operculum is absent.

Head has cephalic lappets, which help in the collection of food. There is a pair of short and subulate tentacles bearing eyes on their outer bases. Foot is short and rounded, and mainly helps in clinging to the substratum. Mantle margin is thrown into a number of folds and bears repugnatorial glands. Mantle cavity is elongate and consists of monopectinate ctenidium, a bipectinate osphradium and a well-developed hypobranchial gland. Anteriorly the mantle is bifurcated to form a pouch that leads the food into the mantle cavity.

Radula is taenioglossate, but short and reduced. Buccal mass is small and has reduced jaws. There are elongate salivary glands but no oesophageal glands. Stomach consists of a crystalline style enclosed in a sac.

These are protandrous hermaphrodites. Male has a penis that is connected to a short seminal groove. Eggs are incubated inside the female. Larval stage is suppressed. It may be planktotrophic or lecithotrophic. These are microphagous and feed by filter mechanism.

The family consists of three genera namely *Crepidula*, *Calyptraea* and *Crucibulum* and several species. All the three genera have representative species in India. The genera and species are distinguished on the basis of their shell characters, such as the position of the apex, sculpture and the nature of internal shelf.

Crucibulum extintorium (Lamarck. 1836)

(Pl. 29, fig. 8, 9)

Cup and Saucer Limpets. Shell small, up to 20 mm in height and 30 mm in diameter, shape extremely variable, thin, usually orbicular to squarely ovate, conical, flat or elevated, apex sharp, recurved and central. Internal shelf not flattened but folded and compressed, attached to the polished side towards which the apex inclined. Surface sculptured with coarse spiral striae. Coloured white or pale brown with or without pale pink radiating lines and chestnut spots.

India : Karnataka, Tamil Nadu : Gulf of Mannar (common on hard rocky and coral substrata); Orissa, Andamans. Indo-West Pacific.

Crepidula walshi Herrmannsen in Reeve, 1858

(Pl. 28, fig. 9, 10)

Shell small, up to 9 mm in height and 23 mm in diameter, elongately ovate, flattened, spire obsolete towards posterior edge, margins irregular, internal shelf flattened and partly covers the aperture, arises from below the apex, attached at both ends. Surface with fine concentric striae and coarse growth lines.

India : Gujarat, Maharashtra, Tamil Nadu, Orissa. Indo-West Pacific, common.

Family CAPULIDAE

Shell is limpet-like and cap-shaped. It can often be confused with that of Hipponicidae but the spire whorls are prominently coiled and extend often beyond the posterior margin. Adductor scar on the interior is horseshoe shaped or ovate. Aperture is large. Periostracum, when present is generally fringed at the margin. Operculum is absent.

Head bears a pair of short tentacles with eyes at their outer bases. Foot is simple and suborbicular, and in some with a thin stretchable anterior part. There is a proboscis with mouth at its base. Radula is taenioglossate. There are no oesophageal glands. Stomach contains a crystalline style, a gastric shield and a sorting typhlosole that helps in the ciliary feeding. These are protandric hermaphrodites and do not possess a gonopericardial duct.

It is a small family with three genera and few species distributed in the tropical seas. These live as commensals on bivalves. Of the three known genera, *Capulus* Montfort, 1810, *Krebsia* Moersch, 1877 and *Neojanacus* Suter, 1907, only the first is known by a few species in India.

Capulus fragilis E.A. Smith, 1904

(Pl. 28, fig. 5, 6)

Shell small, up to 10 mm in height and 8 mm in diameter, thin, cap-shaped, apex extends beyond the posterior margin. Surface smooth except the growth striae. Colour brown, interior white.

India : Bay of Bengal, 750 m, Laccadive Sea, 350 m, very rare.

Capulus irregularis E.A. Smith, 1895

(Pl. 28, fig. 1, 2)

Shell small, up to 12 mm in height and 10 mm in diameter, thick, cap-shaped, apex conspicuously coiled overhanging the posterior margin. Sculptured with concentric foliated ridges. Colour cream with white apex and interior.

India : Gujarat : Saurashtra Coast, 60 m; Laccadive Sea, 66 to 80 m, very rare.

Family XENOPHORIDAE

Carrier Shells

Shell usually is small to medium in size, occasionally up to 100 mm in diameter. It is trochoid and broadly conical with a short spire and flattened concave base. Aperture is oblique, low and wide. It may be imperforate or when umbilicus is present it may be partly obscured by the columellar callosity. Operculum is roughly oval, with nucleus on the outer edge, outer surface smooth, inner surface with an impression of the attachment and non-attached area.

Animal has a peculiar habit of attaching empty shells, coral pieces, pebbles or sand grains and hence their popular name. Cementing of foreign objects is carried out in a most methodical way and often very specific. The objects are carefully selected and fixed with the help of secretion from mantle, which acts as glue. In most of the species attachment of foreign objects occurs only in the juvenile stage but in some it continues throughout the snail's growth. These objects are generally attached to the periphery or the peripheral flange.

Head bears a pair of long, slender and cylindrical tentacles with eyes situated at their outer bases. Foot is divided into two by a transverse fissure and helps in rapid leaping movement. Operculum provides the necessary anchor during its movement. Mantle cavity, on its left consists of a monopectinate ctenidium, a long, thread like bipectinate osphradium and a hypobranchial gland. Buccal mass is very strong. Stomach contains a crystalline style in a sac.

Sexes are separate. In male there is a penis behind the right tentacle that possesses a lateral process. A narrow pallial groove leads to the penis. Female has closed albumen and capsule glands.

Carrier shells occur in shallow waters where dead and broken shells, pebbles etc. are easily available. These are deposit feeders extending from 20 to 700 m. Some feed on microscopic algae. Worldwide as many as 25 species under the genus *Xenophora* are known; seven species are reported from India, but the following six are dealt below :

Xenophora (Xenophora) corrugata (Reeve, 1842)

(Pl. 30, fig. 11–13)

Shell of medium size, up to 48 mm in height and 64 mm in diameter, conical but depressed, sutures deep, usually covered with empty bivalve shells and stones on the edges of all whorls. Umbilicus closed, base slightly concave, sculptured with oblique, strong spiral ribs crossed by growth lamellae with nodules at intersections. Colour white or yellowish brown.

India : Kerala : Malabar coast; Tamil Nadu : Gulf of Mannar, Madras; Orissa : Gopalpur; West Bengal : Sandheads off Calcutta. Indian Ocean. Persian Gulf and tropical east Africa.

Synonym : *Xenophora caperata* Philippi, 1855.

Xenophora (Xenophora) pallidula (Reeve, 1842)

(Pl. 30, fig. 7, 8)

Shell of medium to large size, up to 35 mm to 50 mm in height and 55 mm to 70 mm in diameter, thick, trochoidal, base slightly concave. Attachment of shells and debris on all whorls, largest radiate from the periphery of shells like wheel spokes. Aperture broad, umbilicus smaller in proportion to the size of the shell, columella partly obscures the umbilicus. Base sculptured with wavy, oblique striae crossed by curved growth ridges, those in the centre granular, surface covered with wavy riblets. Colour yellowish white.

India : West Bengal, Tamil Nadu, Andamans, offshore, about 100 m. Indo-West Pacific. 50–1050 m, mostly on the continental slope (Ponder, 1983).

Xenophora (Xenophora) solarioides solariodes (Reeve, 1845)

(Pl. 30, fig. 5, 6)

Shell small, spire depressed, umbilicus deep and rather wide, with a subangulated border. Whorls convex, sculptured with five, close wavy striae crossed by growth lines. Base flat to lightly convex, sculptured with 3–6 spiral cords over inner half, umbilicus with several weak spiral threads within. Dorsal surface obscured by relatively large foreign objects. Colour yellowish white, aperture white.

India : Karnataka, Kerala, Andhra Pradesh : Visakhapatnam; Andaman Islands; 48–90 m depth. Indo-Pacific, Red sea to North Australia, 1–170 m depth (Ponder, 1983).

Xenophora (Onustus) indica (Gmelin, 1791)

(Pl. 30, fig. 14–16)

Shell moderately large, up to 60 mm in height, thin, delicate and depressed with very faint sutures. Attaches small pebbles or bits of shells only to first two or three whorls, the process is discontinued in the adult stage. Base concave and deeply umbilicate, outer edge of aperture a flat ridge and from here fine growth lines extend into the umbilicus, a thin, smooth, shiny irregular skirt outside the ridge. Sculptured with close-set, fine, radial riblets crossed by oblique, uneven striations. Cream coloured, base white from ridge to umbilicus.

India : Orissa, Tamil Nadu, Pondicherry, Andamans. Indo-West Pacific.

Synonym : *Onustus helvacea* (Philippi, 1852)

Xenophora (Stellaria) chinensis (Philippi, 1841)

(Pl. 30, fig. 1, 2)

Shell of moderate size, 28 mm in height and 55 mm in diameter, almost twice as wide as high. Umbilicus broad and deep. Foreign objects small, attached to only a few top whorls leaving

most of dorsal surface exposed. Sculptured with rather close-set granular irregular ridges crossed by undulating growth striae. Base sculptured with spiral and radial ridges forming beads at intersections. Colour yellowish white, aperture white.

India : Andamans. Indo-Pacific.

Xenophora (Stellaria) solaris (Linnaeus, 1764)

(Pl. 30, fig. 9, 10)

Shell large, up to 70 mm in height and 90 mm in diameter, thin, orbicular, depressedly conical, spire low and whorls convex with hollow blunt protruding spines at the periphery obscuring the suture, tubular spines arise from a weakly scalloped ridge. Foreign objects attached to only the first few whorls and sometimes may be even absent. Aperture oval, base almost flat, umbilicus broad and deep with strong, wavy, uneven, nodulose, oblique radial cords. Colour light brown, aperture smooth, shiny dark brown.

India : Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, West Bengal. Indo-West Pacific.

Offshore form, moderately common at depths 25 to 100 m. The shells are usually collected in trawl nets.

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Family CYPRAEIDAE

Cowries

These are most popular with man from times immemorial and are known as the jewels of the sea. Unlike other gastropods, cowries have a dome-shaped and almost hemispherical shell, which is small to large, up to 150 mm in length. Juvenile shell is strikingly different from that of an adult. A spiral shell is present in the early stage but on maturity the outer lip turns in, thickens and teeth develop on it and the inner lip (columella). Adult shell is ovate pyriform, domed, globular or hemispherical. Spire is very much reduced and cannot be easily noticed as in other gastropods. Surface is smooth, highly polished with attractive colours. It has an elongate aperture on its base and generally beset with teeth on the inner and upper lip. Posterior and anterior canals are mere extensions of the aperture. Fossula is distinct, with the anterior margin edged by a rib. Operculum is absent.

Mantle is also as colourful as the shell. It is bilobed and when extended the two lobes cover the entire surface of the shell. The meeting point of the two lobes is indicated by a sinuous line on the dorsum of the shell. The margins of the mantle are fringed and its surface may be smooth or decorated with tubercles, papillae or branched filaments. When disturbed the mantle is completely retracted inside.

There is a pair of long, filiform cephalic tentacles bearing eyes at their outer bases. Foot is broad and extensible. Mantle cavity contains an arched ctenidium with several lamellae, a triradiate osphradium and a large hypobranchial gland. Radula is long and taenioglossate (2-1-1-1-2).

Sexes are separate and often can be distinguished on the basis of shell characters. Male has a penis and the shell is usually smaller than in female. Eggs are laid in capsules embedded in more or less circular gelatinous mass deposited on hard substrate. Some species have the habit of protecting their eggs within the mantle. Development may be direct or eggs hatch in about one or two weeks releasing free-swimming veliger larvae. Juvenile shells are quite unlike the adult shells. Transformation of the shell from juvenile to adult stage is shown in figs. 27 and 28.

Cowries are represented by about 200 species in all but maximum number of about 140 species occur in the Indo Pacific region. Over 50 species are known from Indian seas. Greatest diversity is seen in the reefward edge and surf beaten zones in the coral reef ecosystem of Andaman and Nicobar Islands, Gulf of Mannar, Gulf of Kachchh and Lakshadweep. Majority of the species inhabit shallow water, but a few may extend into the reef front that remains unexposed even during spring tide. The family is represented by a single genus, which is divided into more than 53 subgenera, some of which are elevated to a generic status by many authors. About 13 subgenera embracing 29 species are described in this volume.

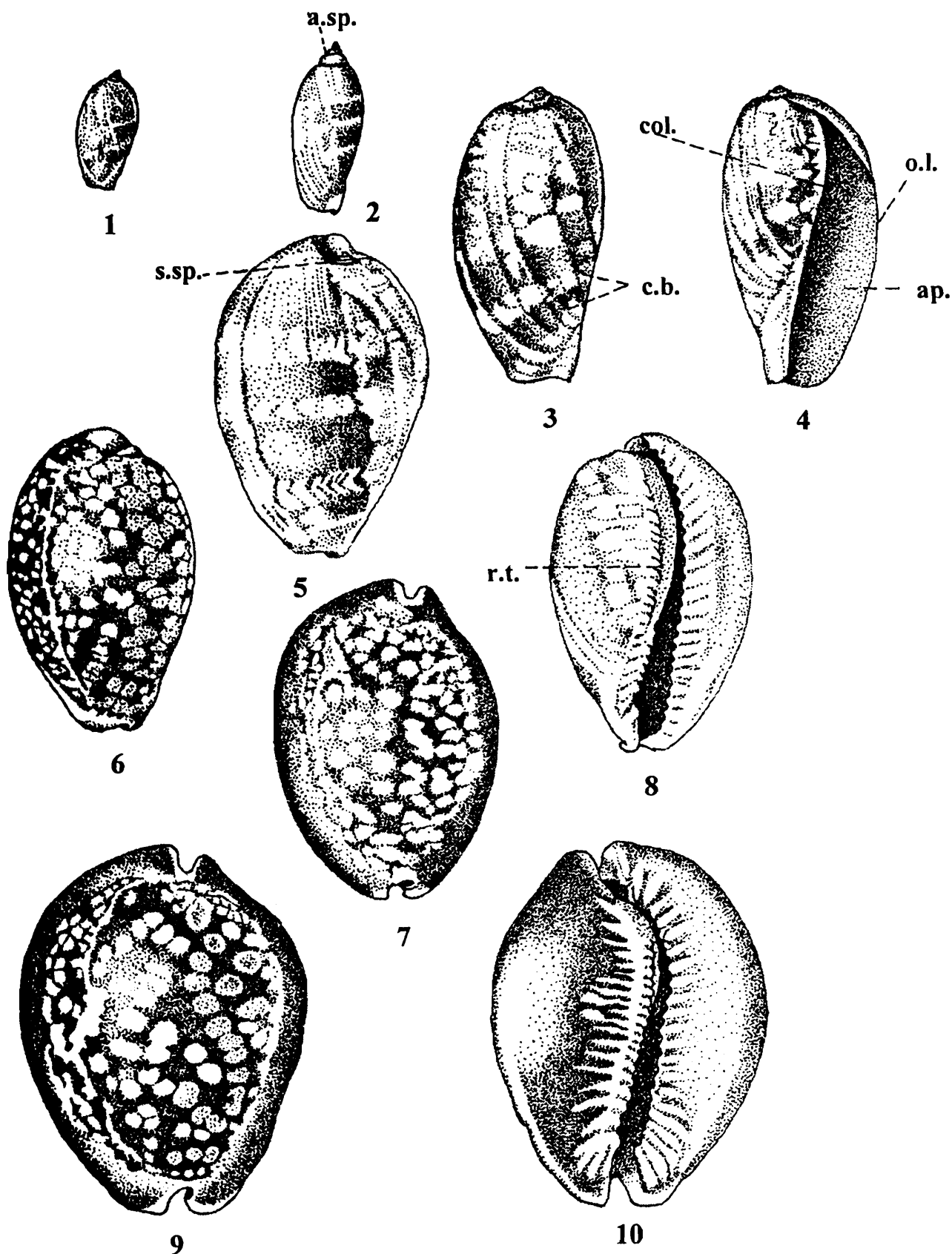


Fig. 27. Developmental stages in coury (after Ray, 1951)

1-4. Bulla-state (a. sp.-acuminate spire; ap.-aperture; c.b.-colour band; col.-columella; o.l.-outer lip. 5. Dorsal view of second stage of growth showing sunken spire (s. sp.). 6. Dorsal view showing adult colouration, markings and also thickening of margins and extremities. 7. Dorsal view with well-developed extremities. 8. Ventral view of developmental stage (of 5), aperture becomes narrow, lips become thickened, rudimentary teeth (r.t.) appear.

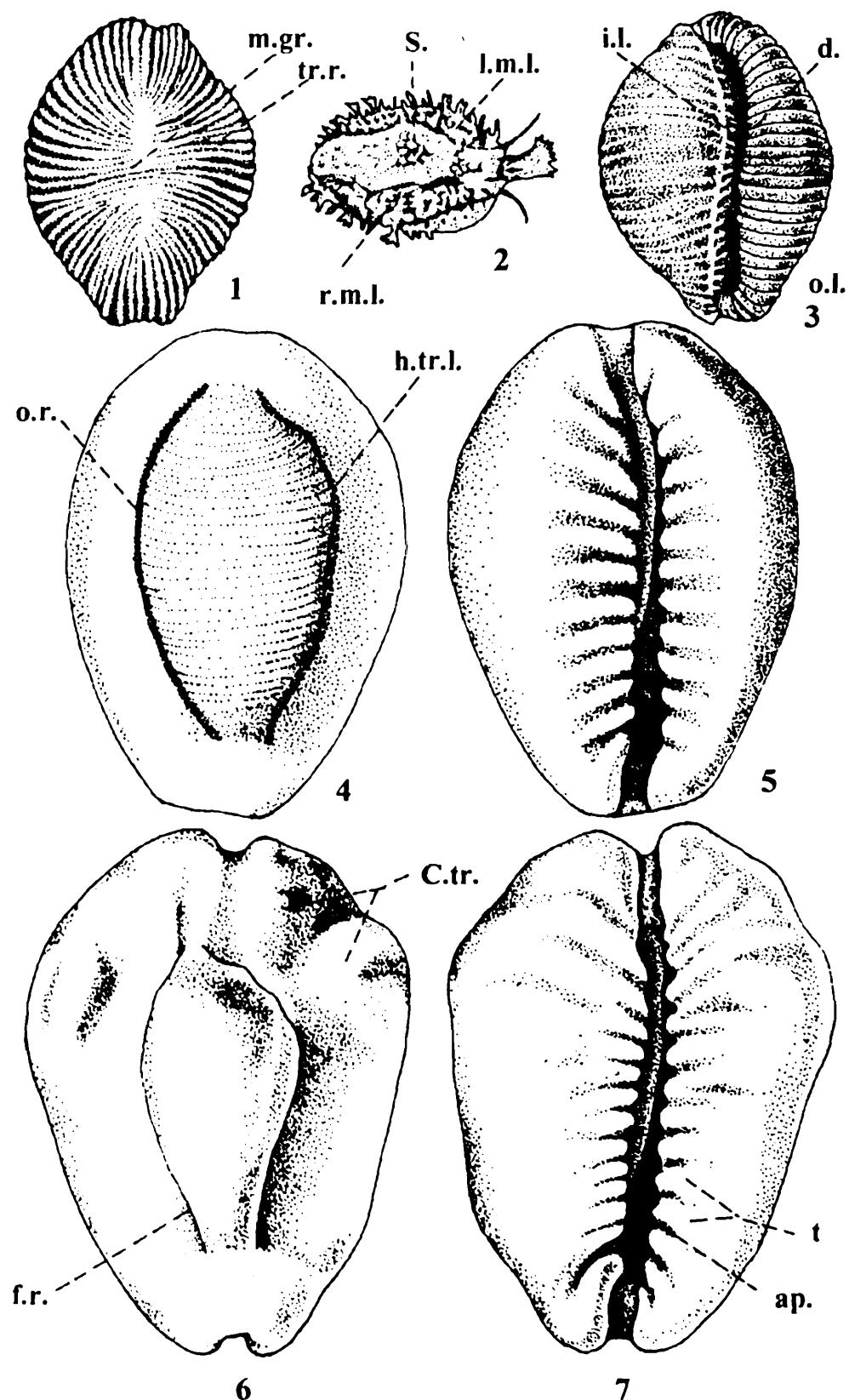


Fig. 28. Developmental stages in coury (after Ray, 1951)

1-3. *Trivirostra oryza*-1. Dorsal view, m.gr.-median longitudinal groove, tr.r.-transverse dorsal ribs. 2. Mantle lobes covering the shell (r.m.l.-right mantle lobe; l.m.l.-left mantle lobe). 3. Ventral view (i.l.-inner lip; o.l.-outer lip; d.-denticulations). 4-5. *Cypraea annulus*. 4. Dorsal view (o.r.-orange ring; h.tr.l.-fine transverse lines). 5. Ventral view. 6-7. *Cypraea moneta*. 6. Dorsal view (c.tr.-callous dorsal tubercles; f.r.-faint dorsal rib). 7. Ventral view (ap.-aperture; t.-teeth).

Cypraea (Cypraea) tigris (Linnaeus, 1758)

(Pl. 31, fig. 5 and Pl. 32, fig. 1, 2)

Tiger Cowry. Shell one of the largest among cowries, up to 65 mm in length, ovate, solid and heavy, dorsum cream-white, with purple black spots, often numerous and close making it completely black, extremities less produced, sides more evenly rounded. Base broad, white with wide aperture, the obscure dark brown blotch on the columella appearing quite small and obsolete. Knob-like projection at the posterior end of the inner lip not so prominent, teeth coarse and strong.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, coral reefs, common. Indo-Pacific.

Cypraea (Adusta) onyx adusta (Lamarck, 1810)

(Pl. 32, fig. 13, 14)

Shell of medium size, up to 43 mm in length, pyriform, dorsum uniformly dark chestnut brown, extremities, sides and base of deeper shade though not jet black as in typical *onyx*. Spire deeply umbilicated and three broad transverse zones on the dorsum distinctly separated from one another by two narrow indistinct bands of lighter hue or cream; anterior extremity constricted and slightly margined; dorsal line rather indistinct to obsolete, teeth coarse and reddish brown, but not produced across the base; aperture wide and greatly sinuous behind.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Nicobars. Indo-Pacific.

Cypraea (Erronea) caurica (Linnaeus, 1758)

(Pl. 32, fig. 11, 12)

Shell of medium size, up to 42 mm in length, elongate, cylindrically ovate with depressed dorsum, cream, freckled with tiny brown dots, ornamented with three bluish brown transverse bands; sides markedly calloused and prominently spotted with dark brown spots, aperture anteriorly wide, labial teeth very strong, base pale fawn to off-white, teeth lighter, interstices pale orange.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar, Madras; Andaman and Nicobar Islands, not common. Red Sea to Polynesia.

Cypraea (Erronea) erronea (Linnaeus, 1758)

(Pl. 32, fig. 5, 6)

Shell small, up to 30 mm in length, pyriformly elongated with narrow extremities, more or less inflated and callus with sunken spire, dorsum bluish gray with three brownish bands, freckled with brownish marks, occasionally with an irregular brownish blotch in the centre, aperture

wide anteriorly, sides and base uniformly white to creamy white in colour, columellar teeth closer than the labial teeth.

India : Tamil Nadu : Gulf of Mannar, Madras; Andaman and Nicobar Islands, moderately common. Mauritius to Polynesia.

Cypraea (Erosaria) caputserpentis (Linnaeus, 1758)

(Pl. 30, fig. 12; Pl. 32, fig. 7, 8)

Shell small, up to 30 mm in length, polished, triangularly ovate, slightly gibbous on the dorsum, central oval area adorned with numerous unequal white specks and reticulate markings and bounded on the sides by a broad conspicuous, dark brown or chocolate or blackish brown band, margins thickened, expanded on either side and distinctly angular, extremities mostly obtuse and conspicuously blotched with rich orange or orange-brown or grayish blue. Upper edges of base dark brown or chocolate and middle part off white, teeth large and white, interstices white.

India : Gujarat, Tamil Nadu : Gulf of Mannar; Andhra Pradesh : Visakhapatnam, Andaman and Nicobar Islands. East Africa to Polynesia and Hawaiian Islands.

Cypraea (Erosaria) erosa (Linnaeus, 1758)

(Pl. 31, fig. 13; Pl. 32, fig. 9, 10)

Shell moderately large, up to 50 mm in length, solid, rather ovate oblong, dorsum fawn to olive brown and profusely freckled with numerous minute white specks and also sprinkled with brownish spots ocellated with grayish; extremities rather broad, produced and ridged, with a longitudinal slit and chest-nut brown; sides white, usually thickened with callous deposit, adorned almost in the centre with broad conspicuous squarish livid brown blotches (one on each side); teeth large and strong, labial teeth more so than the columellar ones and extending right across the base, base whitish, with livid blotches at the upper margin; aperture mostly dilated in front but slightly curved posteriorly; inner lip bluntly produced.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, common in shallow water reefs. Indo-Pacific.

Cypraea (Erosaria) gangrenosa reentsi (Dunker, 1852)

(Pl. 32, fig. 15, 16)

Shell small, oblong ovate or subdeltoidal, dorsum fulvous or fulvous grayish and marked with fine whitish transverse striations and dark brown spots, terminal blotches larger, dark-brown, sides suffused more frequently with whitish enamel, lateral spots less distinct.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, not common. Indo-West Pacific.

Cypraea (Erosaria) helvola (Linnaeus, 1758)

(Pl. 32, fig. 17, 18)

Shell small, up to 30 mm in length, ovate and broad, dorsum with numerous star-shaped brown spots, lateral longitudinal bands chestnut to dark chestnut and sometimes much expanded on either side making the central area on the top small and narrow; extremities less blunt, lilac. Base rich brown, teeth coarse, fossula generally shallow, with 1 to 4 denticles, aperture mostly dilated in front.

India : Tamil Nadu : Gulf of Mannar, rare. Indo-West Pacific.

Cypraea (Erosaria) miliaris (Gmelin, 1791)

(Pl. 32, fig. 3, 4)

Shell of medium size, up to 43 mm in length, somewhat stout and high, oblong-pyriform, pale ochre to olive or even olive yellow, with all the dorsal spots of different sizes pure white but never ocellated, a distinct dorsal line; extremities produced and distinctly lineated with brown; margins angular, less broad, thickened with white callosity on each side and marked conspicuously with close, small and large brown spots. Base creamy white and slightly flattened; aperture rather wide and much curved behind, columellar teeth finer and long, while two anterior most labial teeth more sharp and projecting than the rest, fossular denticles 1-3.

India : Gujarat : Gulf of Kachchh; Maharashtra : Bombay; Karnataka : Konkan Coast; Andaman and Nicobar Islands. Indo-West Pacific.

Cypraea (Erosaria) poraria (Linnaeus, 1758)

(not figured)

Shell small, up to 25 mm in length, solid, ovate to deltoidal, dorsum brown and freckled with numerous white specks mostly encircled with conspicuous brownish rings; margins with slight callous thickenings and their upper edge showing indistinct pits especially towards the posterior end, sides and base pale purple, which on the base fades away to whitish when nearing the aperture; aperture wider and more sinuous behind, teeth small, white, close-set and slightly produced across the base.

India : Tamil Nadu : Gulf of Mannar, Andaman and Nicobar Islands. Indo-Pacific.

Cypraea (Erosaria) ocellata (Linnaeus, 1758)

(Pl. 33, fig. 1, 2)

Shell of medium size, up to 32 mm in length, ovate or deltoidal, dorsum rich yellow ochre or bright brick red and profusely sprinkled with numerous small white rounded spots frequently pupilled or ocellated with dark brown or black, ocellated spots a few in number; sides thickened,

somewhat expanded, obscurely pitted and lineated, with brown dots extending over a portion of the white base below; teeth strong, equal, distantly placed, partly produced and brown streaked, outer ends of terminal ridges painted with brown, aperture interior purplish; dorsal line not very impressive, pale greenish and subcentral.

India : Gujarat : Gulf of Kachchh, Port Okha, Dwaraka, Porbander; Maharashtra : Ratnagiri; Kerala : Quilon; Tamil Nadu : Gulf of Mannar; Andhra Pradesh : Bheemunipatnam, Visakhapatnam; Andamans, common in Gujarat. Indo-Pacific.

Cypraea (Erosaria) turdus winckworthi Schilder and Schilder, 1938

(Pl. 33, fig. 3, 4)

Shell moderately large, up to 50 mm in length, ovate or subdeltoidal, dorsum fulvous to greenish and profusely sprinkled with small, unequal fulvous brown spots and dots mostly assuming a dot like pattern by confluence, margins swollen and angular, but hardly pitted; extremities produced, crenulated and often tinged with pink both above and below; aperture rather wide, but curved behind rather abruptly; base whitish and sparsely spotted near the upper margin, teeth coarse and distantly placed.

India : Gujarat : Port Okha, Dwaraka; Maharashtra : Bombay. Persian Gulf to West Coast of India.

Cypraea (Gratiadusta) lentiginosa (Gray, 1825)

(Pl. 23, fig. 17, 18)

Shell of medium size, up to 32 mm in length, somewhat ovately pyriform, dorsum bluish-white, obscurely banded with three internetted transverse rows of brownish zigzag markings and irregularly freckled all over with numerous distinct minute brown specks (hence the name Freckled Cowry); extremities a little produced, thickened and ornamented with conspicuous dark-brown or blackish-brown spots, sides margined, sprinkled with dark-brown or blackish-brown spots and so also the upper margins of the white base; aperture narrow, teeth large, strong, somewhat distant and nearly equal and slightly produced across the base, columellar callus and fossula both very shallow.

India : Gujarat : Gulf of Kachchh, Porbander. Gulf of Suez to Sri Lanka.

Cypraea (Gratiadusta) pallida (Gray, 1824)

(Pl. 33, fig. 5, 6)

Shell small, up to 30 mm in length, pyriform or ovate, dorsum greenish-straw coloured with three obscure bands, profusely freckled throughout with minute irregular fulvous brown dots, extremities slightly produced, painted on each side with a conspicuous brown or purplish-brown spot, thickened and rounded, whitish with distinct purplish-brown spots here and there; base

white, slightly depressed and unspotted, columellar teeth small, close and confined to the margin of the lip, coarse and thickened.

India : Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar; Andhra Pradesh : Visakhapatnam, Bheemunipatnam; Andamans. Arabian Sea and Bay of Bengal.

Cypraea (Leparocypraea) mappa (Linnaeus, 1758)

(Pl. 31, fig. 3)

Shell moderately large, up to 50 mm in length, heavily inflated with characteristic dorsal sulcus, dorsum brown with darker reticulated pattern, margins thickened with darker indistinct spots, base white or rich pink, teeth white or orange coloured.

India : Andamans, rare. Indo-West Pacific excluding Hawaii, Indonesia and Australia.

Cypraea (Lyncina) argus (Linnaeus, 1758)

(Pl. 31, fig. 1, 2 and Pl. 33, fig. 7, 8)

Shell moderately large, up to 50 mm in length, cylindrical, dorsum lighter fawn, profusely covered with irregular dark red-brown rings of various sizes (Argus eyes), three to four darker transverse bands, darkest at top, base fawn with two dark brown blotches on either side of wide aperture, often absent on the outer lip, teeth edged with thin brown.

India : Andaman and Nicobar Islands, coral reefs, not common. Indo-Pacific.

Cypraea (Lyncina) lynx (Linnaeus, 1758)

(Pl. 31, fig. 4 and Pl. 33, fig. 9, 10)

Shell of medium size, up to 40 mm in length, oblong ovate, incrassate, bluish-white to brown, dorsum brown or orange, decorated with small brown freckles and larger dark brown spots, dorsal sulcus conspicuous; base convex, whitish, often marked with two sharply cut longitudinal carinae, one on each side both shelving towards the aperture, sides whitish, thickened and peculiarly striated with irregular whitish hair lines extending even to the base and also upwards, and adorned with a few scattered spots of dark blackish-brown, extremities mostly blunt, tipped with white or pale yellow and marked with dark blackish brown spots, aperture rather narrow, teeth strong, interstices bright orange-red.

India : Maharashtra : Bombay; Tamil Nadu : Krusadai Island; Andaman and Nicobar Islands. Indo-Pacific.

Cypraea (Lyncina) vitellus (Linnaeus, 1758)

(Pl. 31, fig. 11 and Pl. 33, fig. 13, 14)

Shell large, longer and narrower than that of Tiger Cowry, up to 71 mm in length, ovate, ventricose, solid, dorsum often fulvous to fawn, broadly obscurely divided into three zones by

transverse bands, ornamented with conspicuous snow-white spots of varying sizes, extremities less produced, anterior extremity slightly attenuated; sides thickened, rounded, arenaceous and finely striated vertically. Base rather convex and white or pinkish-white, aperture rather wide and slightly sinuous behind, teeth white or pinkish-white, labial teeth stronger and sometimes more produced across the base.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific, from Red Sea to New Zealand and Hawaii, shallow coral reefs.

Cypraea (Pustularia) lienardi (Jousseaume, 1874)

(Pl. 33, fig. 15, 16)

Shell small, up to 20 mm in length, ovate-globose, mostly rough, yellowish or creamy to whitish, humped, with the subangular top placed further behind, granulations and dorsal longitudinal sulcus very conspicuous, the latter connecting produced and beak-like extremities, a prominent brown central groove near the spire on the dorsum, a depression near the posterior extremity with a dark brown stain. Aperture narrow and slightly curved on the posterior, teeth extending to margins, light brown.

India : Andaman and Nicobar Islands. Indo-Pacific, from Red Sea to Polynesia and Hawaii, shallow coral reefs.

Cypraea (Pustularia) globulus (Linnaeus, 1758)

(Pl. 33, fig. 17, 18)

Shell small, up to 22 mm in length, globular, smooth and dull yellow, dorsum showing evenly rounded gibbosity which contrasts with the asymmetrical, posteriorly placed hump of *C. lienardi*, and punctated with scattered brown dots, no granulations and no longitudinal sulcus, extremities beaked, posterior extremity rather short, straight and marked with a wart-like callosity. Base mostly unspotted but often with two pairs of brown spots on either side, teeth short, brown and extends slightly on to the margins.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands. Indo-Pacific, coral reefs.

Cypraea (Mauritia) arabica (Linnaeus, 1758)

(Pl. 33, fig. 6 and Pl. 34, fig. 1, 2)

Shell of medium size, up to 48 mm in length, subcylindrical to cylindrical, heavy, broad with flattened base; dorsal sulcus plain, dorsum bluish-white, decorated with a hieroglyphic pattern of axial brown lines interrupted by gaps or reticulations, margins with strong callus, white

cream or pale brown; base creamish, no dark blotch on the columella, teeth large, outwardly extended on to the base, pale or dark brown.

India : Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar; Andhra Pradesh : Bheemunipatnam; Andaman and Nicobar Islands. Indo-Pacific.

Cypraea (Mauritia) mauritiana regina (Linnaeus, 1758)

(Pl. 34, fig. 5, 6)

Shell moderately large, up to 60 mm in length, heavy, solid, dorsum dark chestnut-brown or dark blackish-brown and bluish tinged, with a deep mahogany dorsal line. spire short and hardly projecting, strongly callous margins and a humped back; the anterior extremity dilated rather than attenuated, aperture wider, longer and sinuous behind, base and sides almost black and teeth dark brown with white interstices, labial teeth coarse and more produced.

India : Andaman and Nicobar Islands. Indo-Pacific.

Cypraea (Monetaria) annulus (Linnaeus, 1758)

(Fig. 28-4, 5. Pl. 31, fig. 9)

Golden Ring Cowry. Shell small, up to 25 mm in length, ovoid and heavy, dorsum smoky-white or light brown with usually a narrow but sharply defined dorsal orange- yellow ring around bluish central area. Base flattened or concavely depressed or even convex; aperture rather narrow, but dilated anteriorly and slightly curved posteriorly, teeth coarse and short.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands. Indo-Pacific.

Cypraea (Monetaria) moneta (Linnaeus, 1758)

(Fig. 28-6, 7. Pl. 31, fig. 10 and Pl. 34, fig. 3, 4)

Money Cowry. Shell small to medium in size, up to 35 mm in length, very strong and solid, highly polished and enameled, pentagonal owing to the presence of curious nodules, dorsum yellow or off-white, mostly marked with two or three narrow or slightly broad but obscure greenish or slate-gray transverse bands widely separated from one another, sometimes with annular ring; raised and humped central area separated from the swollen and rounded marginal area by a well marked depression; extremities produced, sides white and faintly yellow. Base mostly white, teeth coarse, strong and more crowded than in *C. annulus*, though not so much produced.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands. Collections from Orissa are dead shells and its occurrence there is doubtful. Indo-Pacific.

Cypraea (Nucleolaria) nucleus (Linnaeus, 1758)

(Pl. 34, fig. 9, 10)

Shell small, up to 15 mm in length, solid, and ovate, bulbously inflated, dorsum yellowish brown or evenly ash-gray, with numerous raised, coarse and closely arranged nodules or pustules, fine transverse riblets connecting the pustules; extremities produced and rostrate, constricted, slightly recurved, dark orange brown; dorsal longitudinal groove quite deep and distinct in adult shells. Base convex, pale brown and transversely numerous strong, conspicuous lines and teeth bordered with reddish lines, aperture narrow and sometimes more curved posteriorly, labial teeth more numerous, but unlike the columellar ones extending right across the base to the outer margin, fossula shallow and denticulate.

India : Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands. Indo-Pacific, Red Sea to Polynesia and Hawaii, shallow coral reefs.

Cypraea (Ponda) carneola (Linnaeus, 1758)

(Pl. 23, fig. 11, 12)

Shell moderately large, up to 60 mm in length, colour pale pink brown with four broad darker transverse bands on the dorsum. Teeth bright purple with violet coloured interstices.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar, Andaman and Nicobar Islands. Indo-West Pacific.

Cypraea (Staphylaea) staphylaea (Linnaeus, 1758)

(Pl. 32, fig. 19, 20)

Pustulose Cowry. Shell small, up to 25 mm in length, subglobular or oblong ovate, dorsum ashy blue or grayish brown, ornamented with numerous, fine, white, close and elevated pustules or granulations, dorsal sulcus deep (hence also called the Groove-backed Cowry), extremities dark orange-brown, the posterior one short, constricted and only rarely recurved. Base convex and fulvous, teeth light brown and produced across the base to the outer margins like transverse ridges and bordered with fine reddish brown lines, fossula concave.

India : Andaman and Nicobar Islands, coral reefs, not common. Indo-Pacific.

Cypraea (Talparia) talpa (Linnaeus, 1758)

(Pl. 31, fig. 7, 8)

Shell moderately large, up to 60 mm in length, narrow and elongate, light weight, dorsum with two broad golden brown bands on cream coloured background, margins and extremities

with shades of dark brown to black, base blackish brown. Aperture narrow with numerous linear teeth.

India : Indian Seas, Andamans. Indo-West Pacific.

Cypraea testudinaria

(Pl. 34, fig. 7, 8)

Shell very large, up to 115 mm in length, one of the largest cowry, cylindrical and heavy, dorsum with dark brown spots on creamy background, irregular light and dark brown blotches on the margins and at the extremities, base cream coloured with light fawn coloured aperture and teeth.

India : Tamil Nadu : Gulf of Mannar (Pamban), Great Nicobar : Galathea Bay. Indo-West Pacific.

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Family TRIVIIDAE

Shell generally is small, less than 20 mm in length. It is cowry-like, with conical or globular shape. Aperture is long and narrow, being more or less straight. Columella and outer lip are with teeth. Anterior siphonal canal is short and deep but the posterior canal is shallow. Sculpture consists of transverse striae or granulations, often with a distinct dorsal groove. Colour is variable but not as conspicuous as in cowries. Operculum is absent.

Head bears a pair of small, dotted tentacles. Mantle is large extending laterally on the shell, and possesses wart-like projections. Mantle cavity consists of an osphradium with coarse lamella and a ctenidium with fine, narrow lamellae. Radula is taenioglossate (2-1-1-1-2). Proboscis is long. Sexes are separate. There is helicoidal echinospira larva in the development.

These occur on compound ascidians on which they feed.

The family is divided into two subfamilies to accommodate about 13 genera and an estimated 200 species. In India it is so far known only by a few species belonging to a single subfamily.

Subfamily TRIVIINAE

Trivirostra hordacea (Kiener, 1843)

(Pl. 35, fig. 1-3)

Shell minute, up to 5 mm in length, subcylindrical, extremities slightly produced. Aperture very narrow and a little off the centre. Outer lip with 25 denticles, columella with 19 denticles, fossula broad and concave. Dorsally with fine transverse ribs on either side separated by a distinct, long dorsal groove, interspaces finely crenulated, colour white.

India : Tamil Nadu : Gulf of Mannar; Andamans, shallow coral reefs, rare. Indo-Pacific.

Trivirostra oryza Lamarck, 1811

(Fig. 28. 1-3. Pl. 35, fig. 4, 5)

Shell small, up to 6 mm length, broadly ovate. Aperture almost central, outer lip with 25 denticles, columella with 17 denticles, fossula narrow protruding towards the labial wall. Surface sculptured with raised transverse ribs separated by broad interspaces, dorsal groove not interrupting the ridges, interstices minutely crenulated. Colour white.

India : Andamans, Indian Seas, rare. Indo-Pacific.

Selected Bibliography

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1. The families Triviidae, Eratoidae and Pediculariidae. *Rec. Indian Mus.*, **46** : 183-213.

Family OVULIDAE

False Cowries

Shell usually is small, not more than 25 mm in length. It is cowry-like and fusiform to subpyriform with an involute spire, moderate thickness and not so polished surface. It is without any attractive colours as in cowries. Aperture is wide, usually with a smooth columella and denticulate outer lip. It is canaliculated at both the extremities and often the canals are long and drawn out. Surface usually is without any prominent sculpture, but in a few with distinct spiral striations. Operculum is absent.

Head bears two tentacles and eyes at their outer bases. Mantle usually is smooth but often may bear pustules or obsolete appendages. Mantle cavity contains a monopectinate ctenidium with numerous smooth and broad lamellae, a triradiate osphradium with fine lamellae. Radula is short and taenioglossate (2-1-1-1-2). Sexes are separate.

These occur mainly on corals, sea fans and alcyonarians and have wide distribution in tropical and subtropical waters. The family includes a subfamily Ovulinae, four tribes and 39 genera with an estimated 200 species. However, in India it is not well known as seen from a few samples representing only a few species.

Subfamily OVULINAE

Ovula ovum Linnaeus, 1758

(Pl. 36, fig. 4)

Shell large, up to 80 mm length, thick and solid. Aperture wide with an extended posterior canal, columella smooth, outer lip coarsely ridged. Surface smooth, shiny white, interior chocolate brown.

India : Andamans : Rutland Island, Ritchie's Archipelago. On soft corals in coral reefs at 6–10 m depth. Indo-West Pacific.

Pseudosimnia (Diminovula) fruticum (Reeve, 1865)

(Pl. 35, fig. 6, 7)

Shell small, up to 11 mm in length, elongate ovate, extremities slightly produced. Aperture wide anteriorly and narrow posteriorly, outer lip thick with about 18 prominent teeth extending transversely to its outer margin giving it a serrate look, columella smooth, thickened at the posterior end and with a prominent terminal ridge anteriorly. Dorsum with obsolete transverse striae, colour uniformly white with three fawn transverse bands.

India : Maharashtra : Bombay, rare, Andamans, on soft corals. Red Sea to Fiji Islands.

***Pseudosimnia (Diminovula) frumentum* (Sowerby, 1828)**

(Pl. 35, fig. 12)

Shell minute, up to 5 mm in length, fusiform with produced extremities. Aperture narrow, dilated anteriorly, outer lip rather angulated and flattened with conspicuous teeth extending on to the margin, columella smooth and angulated at the margin, fistula steep, concave and crenate. Dorsum humped at posterior half with a keel. Sculptured with close-set transverse striae at both the ends leaving a smooth central part. Colour pink to purple with a transverse zone at the hump.

India : Indian Seas, no specific locality, rare. Indo-Pacific.

***Pseudosimnia (Diminovula) punctata* (Duclos, 1831)**

(Pl. 35, fig. 16, 17)

Shell minute, up to 5 mm in length, roundly pyriform with extremities produced. Outer lip not much thickened and with about 20 teeth. Dorsum ornamented with three pairs of brown blotches and close-set transverse striae.

India : Tamil Nadu : Gulf of Mannar (Mandapam), on soft coral, not common. Indo-Pacific.

***Primovula singularis* Cate, 1973**

(Pl. 35, fig. 10, 11)

Shell small, up to 12 mm in length and 5 mm in width, dorsum with numerous spiral striae. Aperture straight, outer lip flattened and toothed, extremities produced, posterior one twisted. Colour faded, one specimen pinkish.

India : Bombay. Indian Ocean.

***Primovula striatula* (Sowerby, 1828)**

(Pl. 35, fig. 13)

Shell small, up to 10 mm in length, cylindrically fusiform. Aperture narrow in the middle, wider anteriorly, outer lip with 20 teeth, with a whitish band almost in the middle, with very fine striations throughout. Colour indistinct since the collection is very old.

India : Maharashtra : Bombay, rare. Red Sea to Fiji Islands.

***Volva sowerbyana* Weinkauff, 1881**

(Pl. 35, fig. 8, 9)

Shell small, up to 16 mm in length, fusiform, extremities produced into short and slender canals. Outer lip convex, thick and smooth, columella with about 20 oblique striae and posterior

rib. Dorsum with numerous transverse striae. Colour light flesh pink with an obscure cream band in the centre.

India : Maharashtra : Bombay, rare. Indo-West Pacific.

Volva volva Linnaeus, 1758

(Fig. 29)

Shell large, up to 75 mm in length, dorsum gently arched, with fine transverse striae. Aperture elongate, wide anteriorly, extremities drawn into very long, slightly curved and obliquely ridged canals, columella smooth, outer lip expanded and with thick margin. Colour flesh pink.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar, Andaman and Nicobar Islands, occurs on gorgonids, uncommon. Indo-Pacific.



Fig. 29. *Volva volva* (a) Ventral; (b) Dorsal.

***Calpurnus (Calpurnus) verrucosus* (Linnaeus, 1758)**

(Pl. 35, fig. 14, 15)

Shell small, up to 22 mm in length, cowry-like, ovately angulated. Aperture narrow, dilated anteriorly, outer lip flat and broad with about 24 teeth extending on to the margin. Dorsum with a prominent keel dividing the shell into posterior one-third and anterior two-thirds, rosy, wart-like tubercles at extremities. Colour white, a little pinkish tinge at the extremities.

India : Andaman and Nicobar Islands. Indo-Pacific.

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Family LAMELLARIIDAE

Shell is internal, thin and small, usually not more than 25 mm in height. Body whorl is large with a small spire and impressed sutures. Shell is covered by brown periostracum. Aperture is very large with thin and smooth columella. Outer lip is very simple and thin. Siphonal canal and umbilicus are absent. Surface is smooth or with weak spiral striae. There is no operculum.

Head bears a pair of short tentacles with eyes at their outer bases. Foot is elongate and quadrate posteriorly. Mantle is large and covers the shell partly or completely. Its surface is rugose and bears wart-like projections. Mantle edge is thick with a short, very reduced incurrent siphon and a furrow-like posterior siphon. Mantle cavity consists of a large ctenidium and osphradium. Proboscis is moderate sized with a protrusible buccal mass. Radula is taenioglossate with marginals (2-1-1-1-2) or without marginals (0-1-1-1-0). Sexes are either separate or united. Male has a penis. Eggs are deposited in the holes in ascidians. Larva is a nautiloid echinospira.

These occur on ascidians and cnidarians, and are widely distributed. It is a small family divided into two subfamilies, Lamellariinae and Velutininae with about 9 genera and 50 species. A single species was reported from India.

Subfamily LAMELLARIINAE

Lamellaria (Corvicella) indica Leach

(Pl. 36, fig. 5, 6)

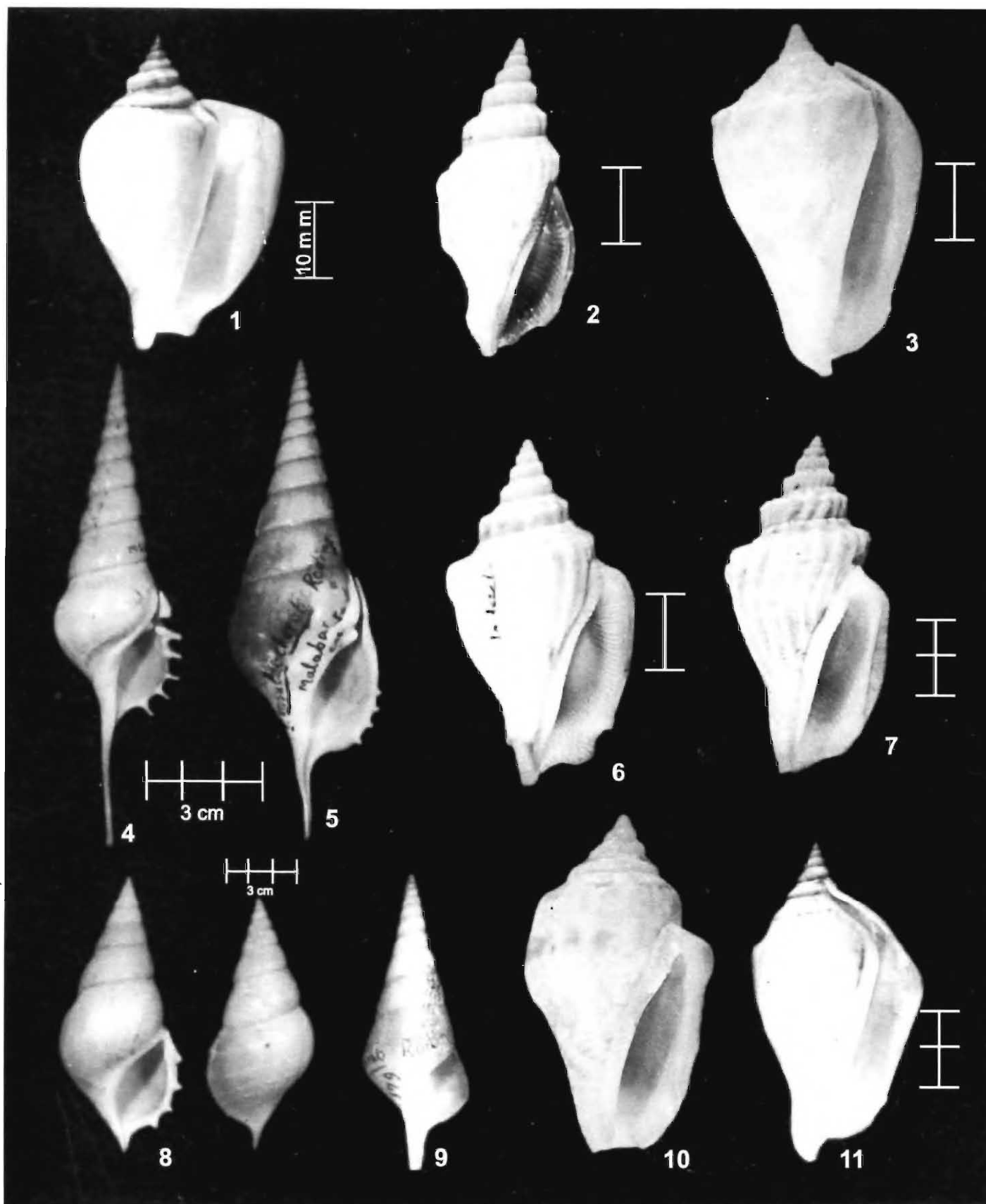
Shell small, up to 24 mm in height, thin, fragile, whorls three, with a depressed spire, shallow sutures. Aperture large, columella smooth and curved, outer lip almost straight and sinuous. Surface smooth covered with brownish periostracum.

India : Tamil Nadu : Kanya Kumari, rare. Indo-Pacific.

Selected Bibliography

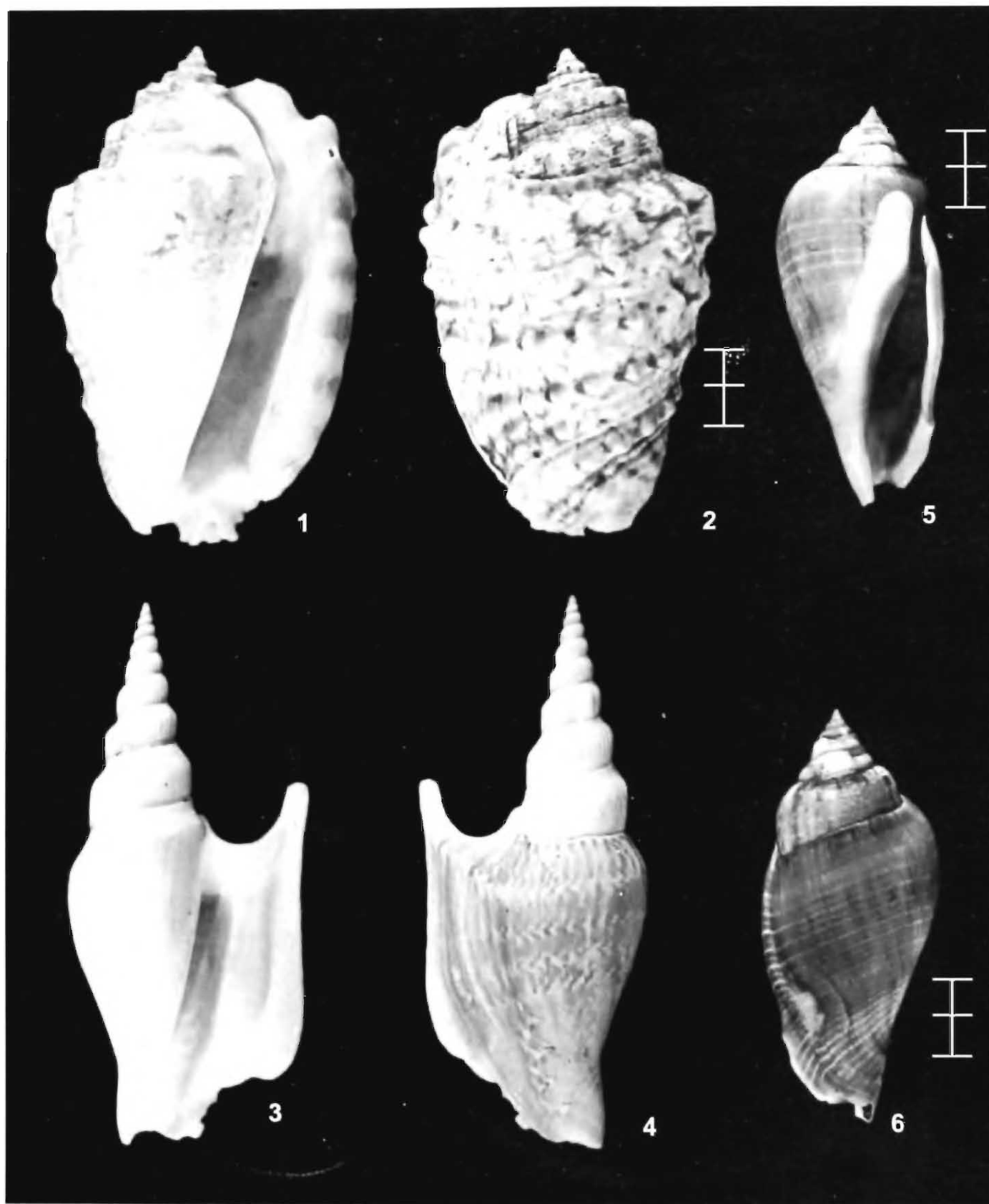
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Plate 25 : Strombidae



1. *Strombus* (*Laevistrombus*) *canarium* : Andamans; 2. *Strombus* (*Canarium*) *erythrinus erythrinus* : Indian Seas; 3. *Strombus* (*Canarium*) *marginatus marginatus*; 4. *Tibia fusus* : Nan Cowry Harbour; 5. *Tibia insulaechorab*; 6. *Strombus* (*Canarium*) *labiatus labiatus* : M22653/4, Fuladu Island, Maldives; 7. *Strombus* (*Canarium*) *labiatus olydius*; 8. *Tibia delicatula* : Bay of Bengal; 9. *Tibia insulaechorab* : juvenile; 10. *Strombus* (*Canarium*) *mutabilis*; 11. *Strombus marginatus succinctus* : Trincomalee; Sri Lanka.

Plate 26 : Strombide



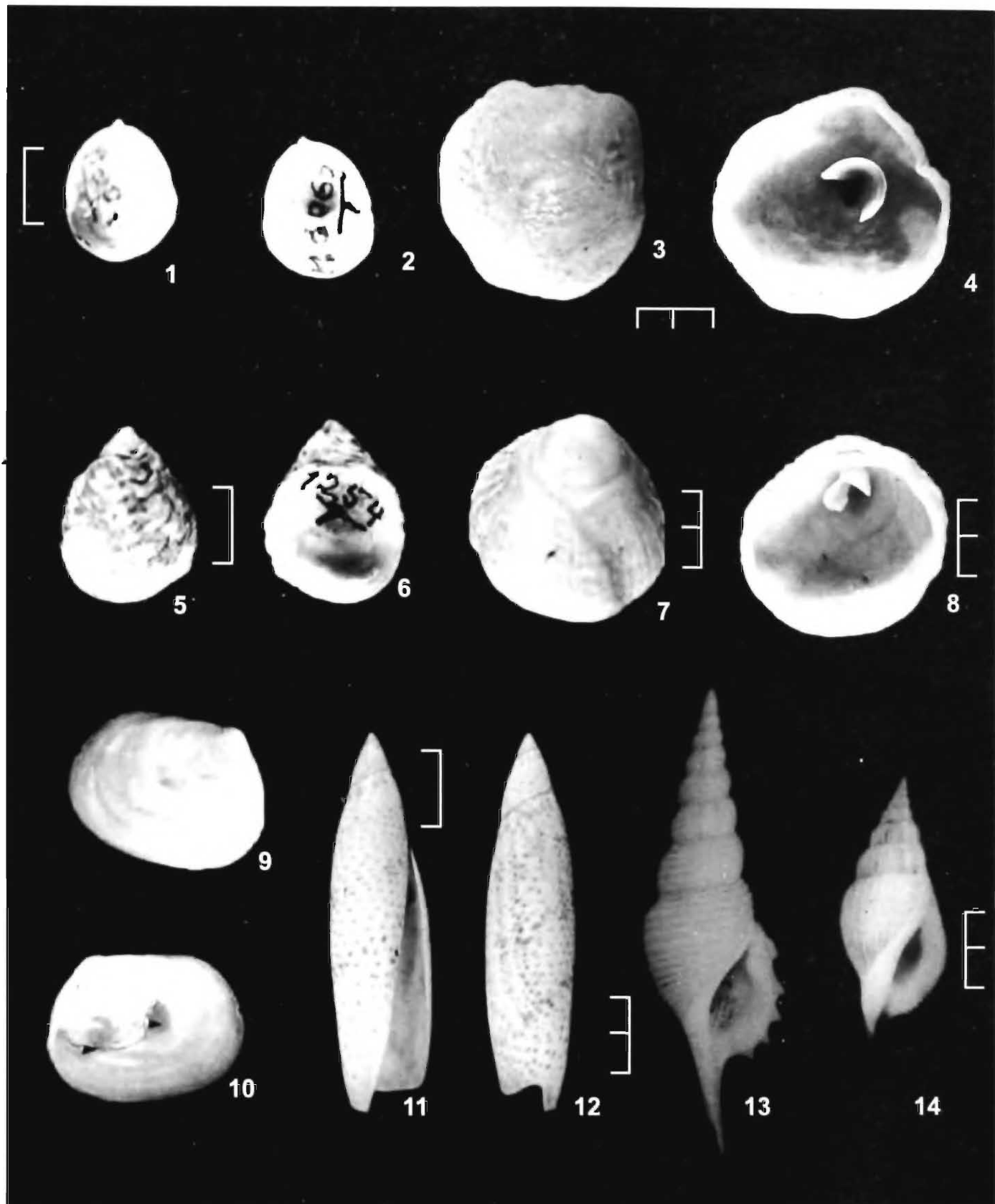
1,2. *Strombus (Lentigo) lentiginosus* : Andamans; 3,4. *Strombus (Doxander) listeri* : Visakhapatnam, Andhra Pradesh; 5,6. *Strombus (Gibberulus) gibberulus* : Chatham, Port Blair, Andamans.

Plate 27 : Strombidae



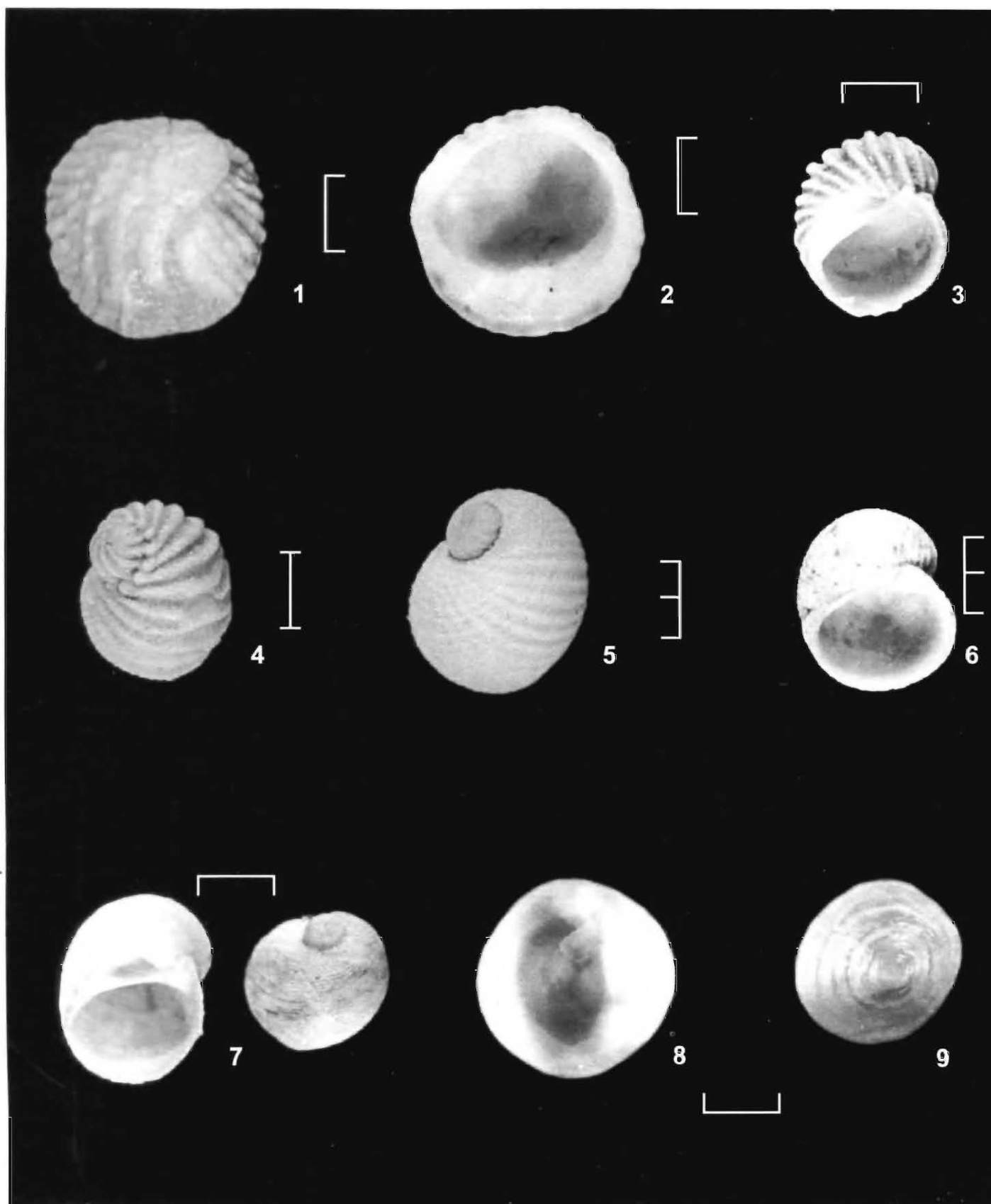
1. *Lambis (Harpago) chiragra chiragra* : male (form rugosa), Singapore, 148.5x82.8mm;
 2- 5. *Lambis (Lambis) lambis* : Andamans, 2. Male, apertural view, 145x80mm.; 3. male, dorsal
 view; 4. Male, side view, 143* x 83.5mm.; 5. female, side view, 195 x 140mm; 6,7. *Lambis (Millepus)*
scorpius indomaris : John Lawrence Island, Andamans, 150 x 63.5mm; 8,9. *Lambis (Lambis) crocata*
crocata : Andamans, 122.3* x 57.8.

Plate 28 : Crepidulidae, Strombidae



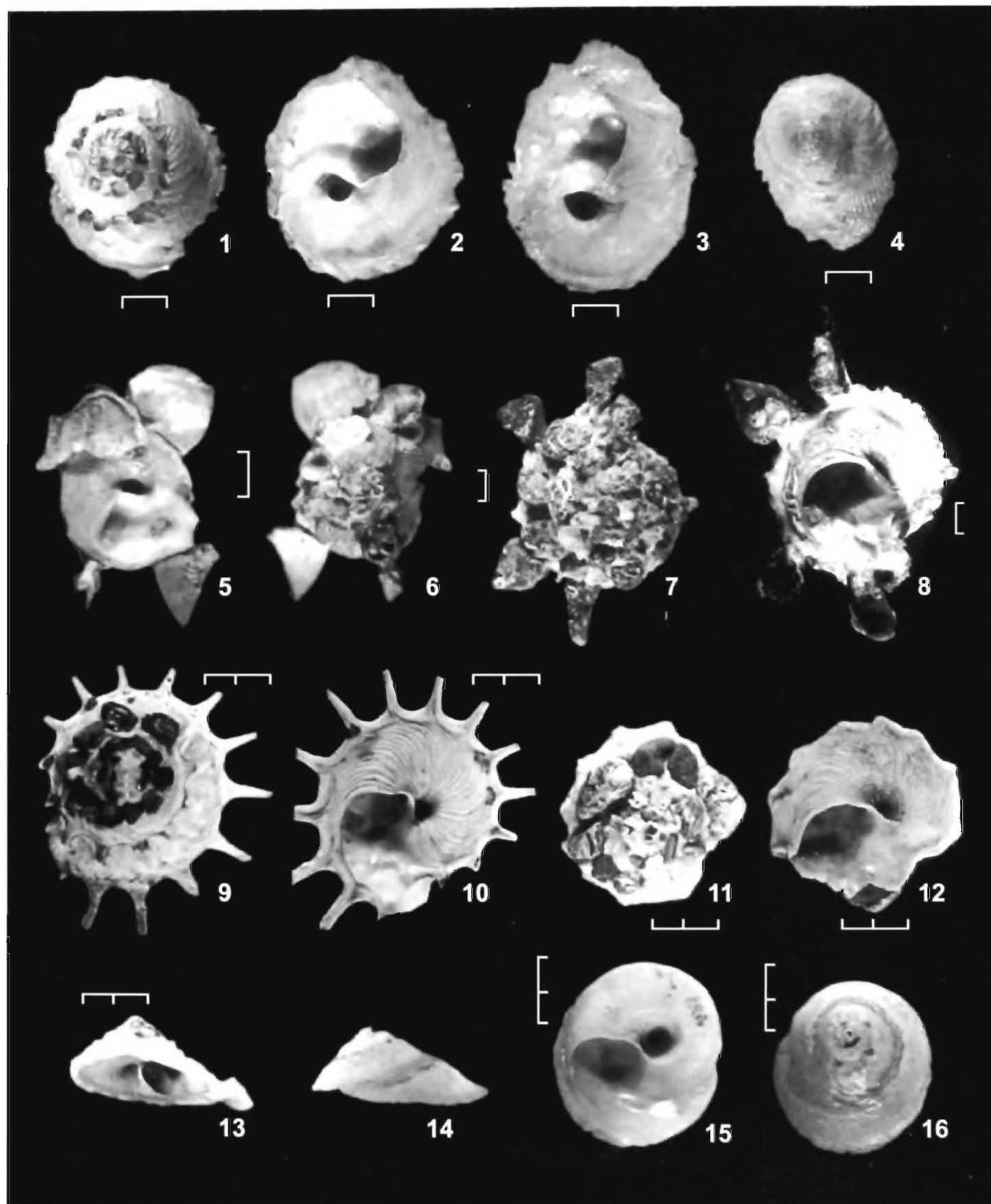
1,2. *Capulus irregularis* : M254/1, 15.5 X 12; 3,4. *Cheilea undulata*; 5,6. *Capulus fragilis* : M3065/1, 12.4 x 10; 7,8. *Cheilea equestris*; 9,10. *Crepidula walshi*; 11,12. *Terebellum terebellum* : Andamans; 13. *Tibia powisi* : Sta. 328, Marine Survey; 14. *Rimella (Varicospira) cancellata*.

Plate 29 : Hipponicidae, Vanikoridae



1,2. *Hipponyx acuta*; 3,4. *Vanikoro plicata* : Andamans; 5,6. *Vanikoro cancellata* : Andamans; 7. *Vanikoro rosea*; 8,9. *Crucibulum extincitorium*.

Plate 30 : Xenophoridae



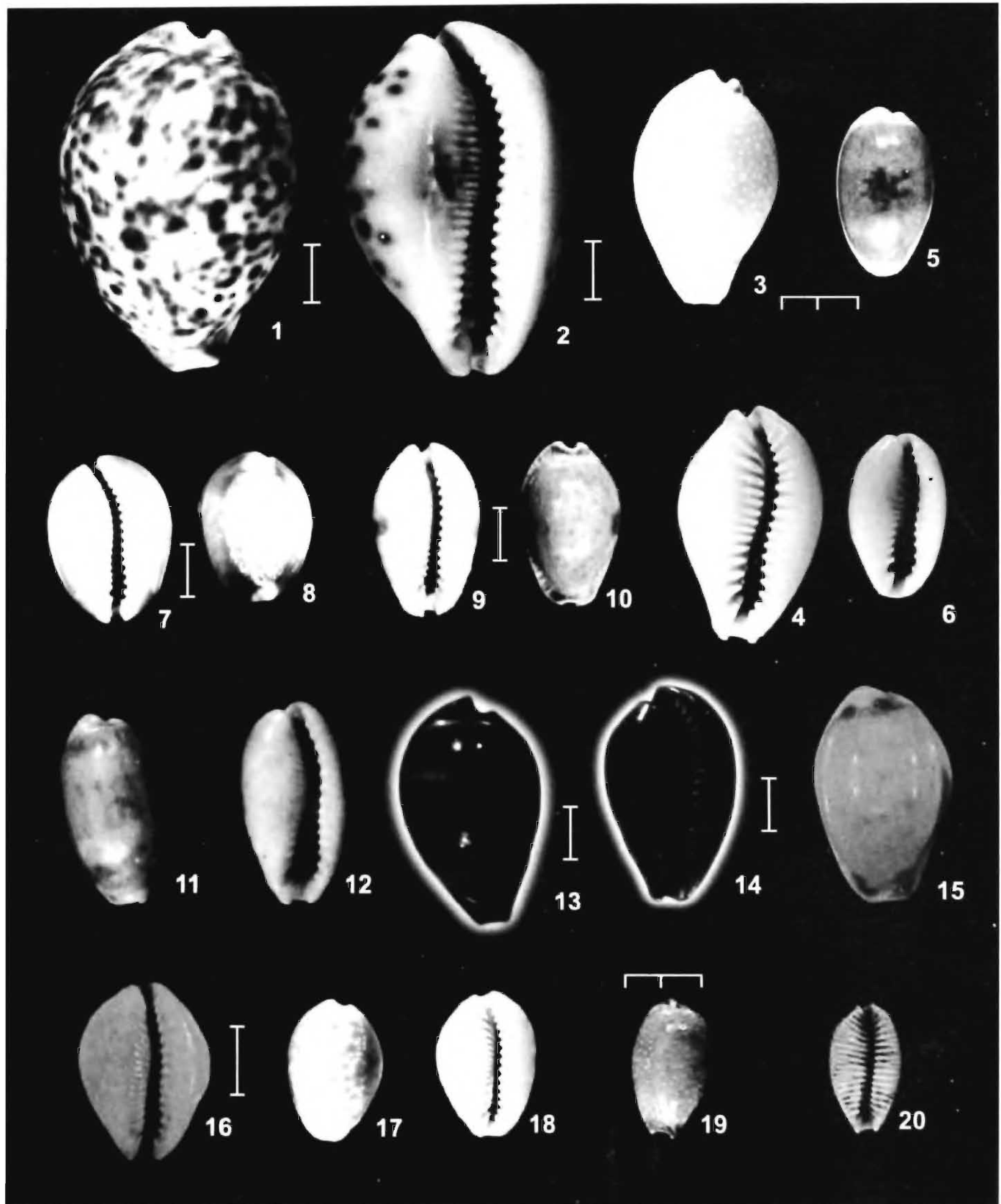
1,2. *Xenophora chinensis*; 3,4. *Xenophora exuta*; 5,6. *Xenophora solarioides*; 7,8. *Xenophora pallidula*; 9,10. *Xenophora solarisn* : M 1181-1182/1; 11-13. *Xenophora corrugata* : M 1481, Puri Orissa; 14-16. *Xenophora indica*.

Plate 31 : Cypraeidae



1,2. *Cypraea argus*; 3. *Cypraea mappa*; 4. *Cypraea lynx*; 5. *Cypraea tigris*; 6. *Cypraea arabica* : M 18827/3; 7,8. *Cypraea talpa* : M 5392/1; 9. *Cypraea annulus*; 10. *Cypraea moneta*; 11. *Cypraea vitellus*; 12. *Cypraea caputserpentis*; 13. *Cypraea erosa*.

Plate 32 : Cypraeidae



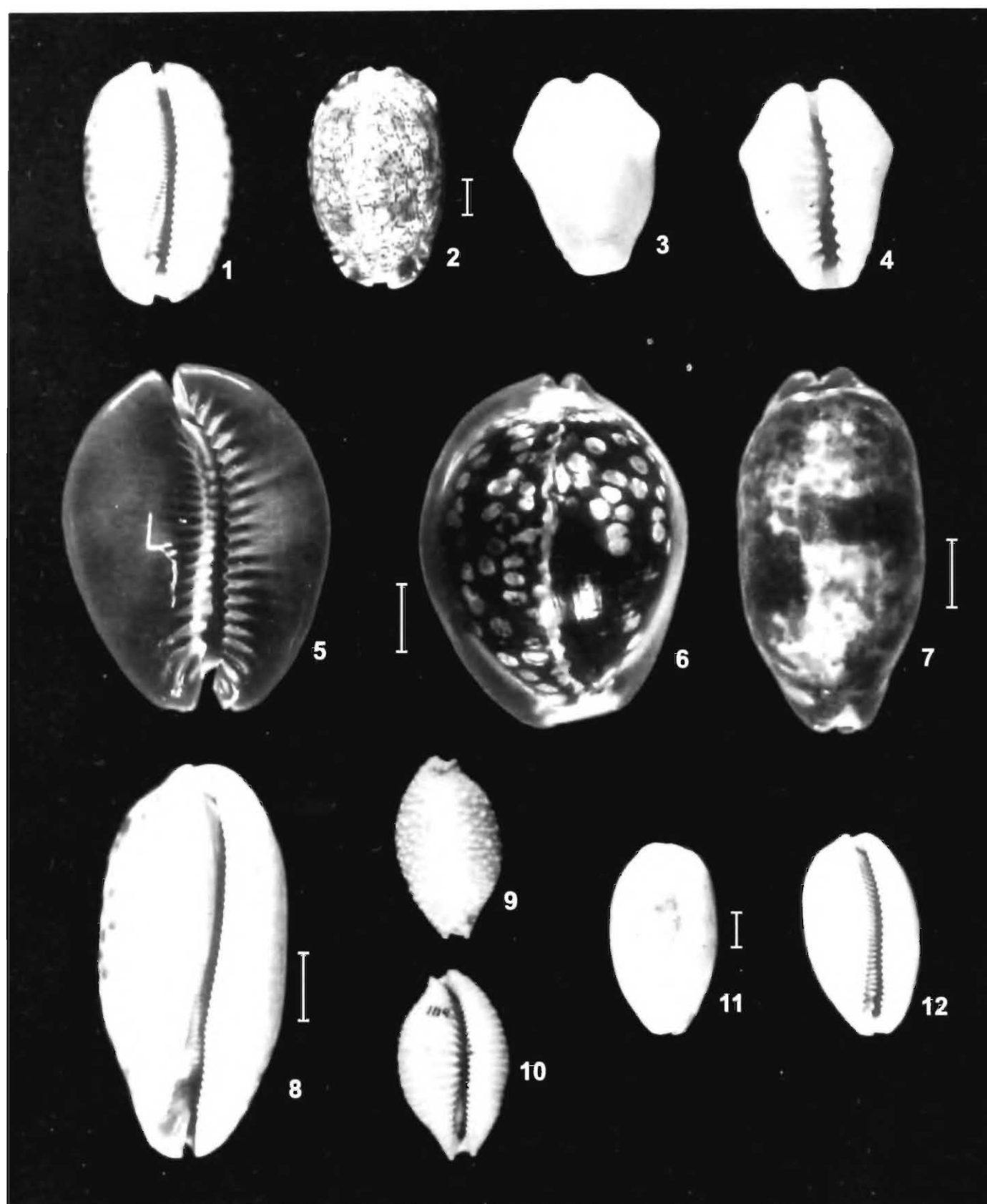
1,2. *Cypraea tigris*; 3,4. *Cypraea miliaris* : M 2806; 5,6. *Cypraea errones* : M 18175/3; 7,8. *Cypraea caputserpentis* : M 2773; 9,10. *Cypraea erosa* : M 18187/3; 11,12. *Cypraea caurica* : M 22619/4, Vanthivu Id. Gulf of Mannar; 13,14. *Cypraea onyx adusta* : M 18745/3; 15,16. *Cypraea gangrenosa reentsi* : M 18148/3; 17,18. *Cypraea helvola* M2795; 19,20. *Cypraea (Staphylea) staphylea*.

Plate 33 : Cypraeidae



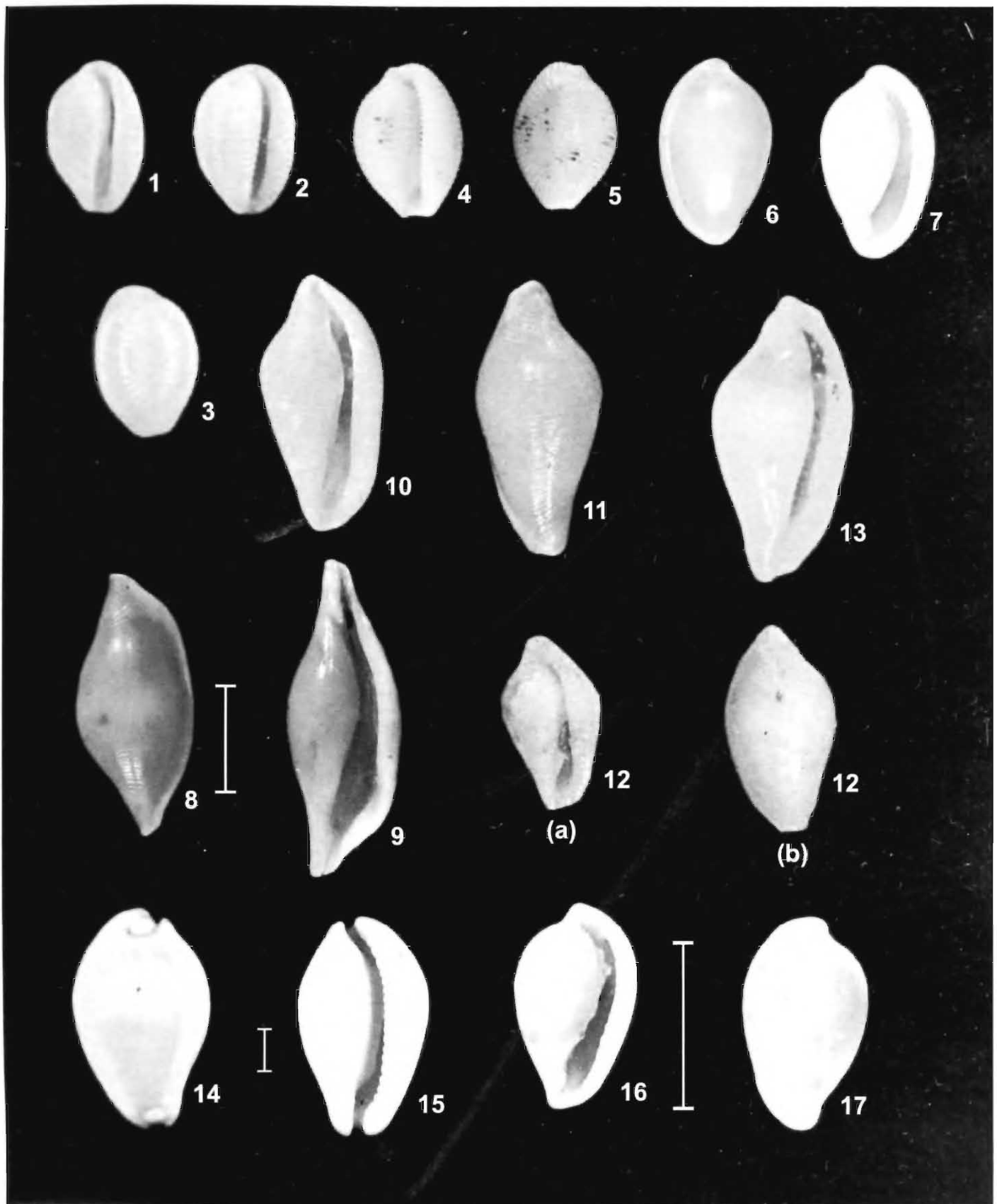
1,2. *Cypraea (Erosaria) ocellata* : M 18222/3; 3,4. *Cypraea (Erosaria) turdus winckworthi* : M 18262/3; 5,6. *Cypraea pallida* : M 21816/4, Dona Paula beach, Goa; 7,8. *Cypraea (Lyncina) argus* : M 2732; 9,10. *Cypraea (Lyncina) lynx* M 18447/3; 11,12. *Cypraea (Erosaria) lamarckii redimita* ; 13,14. *Cypraea (Lyncina) vitellus dama* : M 18471/3; 15,16. *Cypraea (Pustularia) cicercula* (:C.lienardi) : M 18116/3; 17,18. *Cypraea (Pustularia) globules* : M 18126/3.

Plate 34 : Cypraeidae



1,2. *Cypraea (Mauritia) arabica* : M 18827/3; 3,4. *Cypraea (Monetaria) moneta* : 22448/4, Point Calimere, Gulf of Mannar; 5,6. *Cypraea (Mauritia) mauritiana regina*; 7,8. *Cypraea testudinaria* : M 18569/3; 9,10. *Cypraea (Nucleolaria) nucleus nucleus*; 11,12. *Cypraea carneola* : M 2784.

Plate 35 : Triviidae, Ovulidae



1-3. *Trivia hordacea* : x 6, Indian Seas; 4,5. *Trivia oryza* : Andamans; 6,7. *Pseudosimnea (Diminovula) fruticum* : Bombay; 8,9. *Volva sowerbyana* : Bombay; 10,11. *Primovula singularis* : x 3.6, Bombay; 12. (a & b) *Pseudosimnia (Diminovula) frumentum* : x5, Bombay; 13. *Primovula striatula* : Bombay; 14,15. *Calpurnus verrucosus* : East Bay, Katchal, Nicobar; 16,17. *Pseudosimnea punctata*.

Plate 36 : Atlantidae, Lamellariidae



1,2,3 a-e. *Atlanta peronii*; 4. *Ovula ovum*; Rutland Island, Andamans; 5,6. *Lamellaria indica*.

Family ATLANTIDAE

Pearly Nautilus

Shell is very small, usually not more than 10 mm in height, thin, fragile and discoidal. **Body whorl has a keel.** Aperture may be ovate or subtrigonal with a roundish or subtrigonal ovate **corneous operculum.** Colour is uniformly dull white or pale brown. Although the shell looks **small the animal** can be completely withdrawn into the shell.

Head bears large eyes and well-developed proboscis. Foot is separable into anterior and **elongate posterior** part. The former bears a sucker and the operculum is attached to the latter. **Sexes** are separate. Male has a penis and penial sucker.

These are pelagic and occur as epiplankton in the upper layers of the ocean and to a depth of **few hundred metres.** They feed mainly on other planktonic forms, such as ctenophores, salps, crustaceans and other heteropod molluscs. It is a small family containing three genera and **about 18 species.**

Atlanta peronii Leseur, 1817

(Pl. 36, fig. 1–3)

Shell small, up to 7 mm in diameter, thin, fragile, glossy and planospiral. Periphery sharp and with a large crest in undamaged specimens, protoconch multispiral, fine growth striae, colour white or pale brown.

India : East and West Coasts of India, offshore pelagic form and often collected in plankton **nets, common.** Indo- Pacific.

Family NATICIDAE

Moon Shells

Shell usually is small to moderately large in size, occasionally up to 80 mm in length. It is ovate-conic to globose, with a depressed or moderately elevated spire. Body whorl is large and often inflated. Surface is smooth or polished, may have obsolete axial or spiral sculpture. Shell is variously coloured and some of the species can be identified on the basis of their colouration. It has large, ovate to semilunate aperture, with usually oblique outer lip. Columella usually has a callus deposit. The most distinguishing feature of the shell is the presence of a funicle in the umbilicus, which may be open or closed. Funicle is a rib-like structure that grows from the little bulge of the callus on the siphonal canal. Operculum is paucispiral with an excentric nucleus, corneous or calcareous.

Head bears a pair of small tentacles situated wide apart, with a little developed or reduced eyes. Foot is highly developed and it can be extended and spread to an enormous size by its water tube system. When expanded the anterior propodium of the foot folds back and covers much of the head. In the genus *Sinum* the foot can be six to seven times larger than the shell. Posterior part of the foot envelops much of the shell when the animal is active. During this time a slit on the right side permits the circulation of water into the mantle cavity. Foot is used as a spade to dig, as a plough to move through the substratum in search of the prey and to hold and chock its prey. A boring gland situated on the ventral side of the mouth assists in making holes in the bivalves. Mantle cavity consists of a large ctenidium and a narrow osphradium. Buccal mass is protrusible and possesses corneous jaw plates.

Alimentary system consists of a taenioglossate radula (2-1-1-1-2), a well developed foliated gland in the oesophagus and a caecum in the stomach. Sexes are separate and in many can be differentiated externally by their shells. Male has a penis on the right side. In the females there is a long, coiled oviduct, a large albumen gland and mucous gland. Eggs are laid in a jelly-like mass mixed with sand rolled in the form of a ribbon and because of the shape the egg masses are called sand dollars. Eggs hatch in about two to three weeks releasing free-swimming veliger larvae.

Moon shells are burrowing forms, moving actively on sandy or muddy shores along the coast. They plough through the substrate with their massive foot in search of their prey that includes many soft bottom families of bivalves, especially venerids, tellinids and lucinids, and gastropods. The prey is enmeshed in the mucous strands and held firmly by its foot, the special boring gland then softens the shell, the radula grinds through the shell and makes a hole, and finally the proboscis is inserted and the liquidised meat is sucked in. The feeding in naticids involves both mechanical and chemical actions. A number of bivalves washed ashore on a sandy beach can be found with the holes made by naticids.

It is a large family with about 200 valid recent species distributed world-wide, especially in the tropical seas from the intertidal sandy beaches to a depth of about 100 m. Moon shells are commonly seen in soft bottom sediments and sandy beaches of India. About 25 species were reported from India but only the following 22 species are dealt here. Based on their shell shape, sculpture, nature of aperture and operculum, the family is divided into the following four subfamilies (Kabat, 1990, 1991).

1. Ampullospirinae – spire high, whorls tabulated, sutures channelled.
2. Polinicinae – shell globose, usually uniformly coloured, umbilicus open, operculum corneous, cephalopodial portion of the male gonoduct an open groove.
3. Naticinae – usually colourful, operculum calcareous, umbilicus usually funiculate, cephalopodial portion of the male gonoduct closed.
4. Sininae – shell low spired to subauriform and spirally sculptured, animal cannot be retracted completely into the shell.

Subfamily NATICINAE

Natica gualteriana Recluz, 1844

(Pl. 37, fig. 1, 2)

Shell small, up to 20 mm in length, solid, surface glossy, spire low. Aperture semilunar, columella with a conspicuous funicle filling up the major part of the umbilicus which remains a crescent opening. Surface with obscure axial growth striae and a little prominent subsutural radial ribs. Colour dull gray with brown streaks arranged in two to three spiral zones on the body whorl, interior of aperture purplish, umbilicus white. Operculum calcareous with a single marginal rib.

India : Lakshadweep, Kerala, Tamil Nadu : Gulf of Mannar, common; Andhra Pradesh, Orissa, West Bengal : Digba, Hugli-Matla Estuary. Indo-Pacific.

Synonym : *Natica marochiensis* of authors.

Natica lineata (Roeding, 1798)

(Pl. 37, fig. 3, 4)

Shell of medium size, up to 32 mm in length, globose with an inflated body whorl and a slightly elevated spire, apex pointed, surface smooth and finely glossy. Aperture large, columella thin, funiculum entering spirally inwards into the umbilical depression and separated from the parietal callus by U-shaped space. Colouration quite specific, surface ashy white ornamented

throughout with close set orange yellow, wavy, vertical lines, apex partially tinged with pale bluish gray, umbilical space white.

India : Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, West Bengal : Digha, Hugli-Matla Estuary; Andaman and Nicobar Islands, abundantly common in intertidal mudflats and backwaters. Indo-Pacific.

Natica tigrina (Roeding, 1798)

(Pl. 37, fig. 7, 8)

Shell of medium size, up to 31 mm in length, globose with an inflated body whorl and conically exerted spire. Columella with a thick callus at its base, funicle obliquely enters the umbilical depression at its anterior end leaving it open posteriorly. Colour pale brown ornamented all over with small, close-set, rounded, purplish brown spots arranged in regular spiral lines, which may often coalesce with each other, interior of aperture and umbilical area white.

India : Gujarat : Gulf of Kachchh; Maharashtra, Kerala, Tamil Nadu, Pondicherry (not common), Orissa : Chandipur (very common); West Bengal. Indo-Pacific.

Offshore form (10 to 30 m) inhabiting river mouths with fine sand mixed with mud. Egg masses were found in abundance during pre-monsoon and post-monsoon periods towards the mouth of Burhi Balang River, Chandipur (Orissa).

Synonyms : *Natica maculosa* Lamarck, 1838

Natica picta Recluz

Natica vitellus (Linnaeus, 1758)

(Pl. 37, fig. 5, 6)

Shell of medium size, up to 40 mm in length, globose, thick, with rounded whorls and a short spire. Aperture lunar ovate, columella with polished callus posteriorly fusing with the body whorl and covering partly the umbilical depression leaving it anteriorly open, callosity without a spiral groove, funicle inconspicuous and fuses with the umbilical wall. Colour white with two broad, brown spiral bands on the body whorl, apex reddish brown. Operculum with four grooves parallel to the margin.

India : Lakshadweep, East and West Coasts, common. Indian Ocean.

Inhabits sandy beaches near low tide line and beyond. Usually collected in fishing nets.

Synonym : *Natica rufa* Born, 1780.

Naticarius alapapiliones (Roeding, 1798)

(Pl. 37, fig. 15)

Shell small, up to 20 mm in length, globose ovate with a short exerted spire, body whorl broadly expanded towards wide aperture; umbilicus deep and extending anteriorly, parietal callus situated posteriorly, funicle thin and enters umbilical depression at an oblique angle. Sculptured with fine growth striae and subsutural radial ribs. Colour light brown with four narrow, white bands decorated with dark brown rectangular spots, apex violet, interior of aperture purplish, outer lip edge and umbilical area white. Operculum with many grooves parallel to margin.

India : Maharashtra : Bombay; Tamil Nadu : Krusadai Island; Pondicherry, shallow water. Indo-Pacific, common and widespread.

Synonym : *Natica zonaria* Lamarck, 1816.

Naticarius manceli Jousseaume, 1874

(Pl. 37, fig. 9, 10)

Shell small, up to 25 mm in length, spire elevated, suture deep. Aperture moderately large, columella concave, without a callus deposit, a low, rounded funicle entering the C-shaped umbilicus. Surface smooth except for oblique axial grooves in the subsutural region. Colour grayish brown. body whorl with two major rows of faint to conspicuous brown spots, often enclosing in between two additional rows of fine brown dots, base, umbilicus and columella white, funicle brown or tinged with brown terminally, interior of aperture tinged with light brown. Operculum with nine or ten strong spiral ribs, nuclear area with a smooth, irregular callus.

India : Andamans, rare. Mozambique to Philippines.

Synonym : *Natica strongyla* var. *andamanica* Melvill and Sykes, 1899.

Naticarius onca (Roeding, 1798)

(Pl. 37, fig. 11, 12)

Shell small, majority 15 to 16 mm in height, often a few reach up to 23 mm in height, solid, spire low. Aperture semi-ovate, parietal callus prominent, umbilicus opens posteriorly, funicle broad and prominent filling anterior 2/3 of umbilicus, Surface glistening and with growth lines. Colour cream, body whorl with five spiral rows of large and conspicuous dark brown rectangular spots, aperture and nuclear whorls white. Operculum calcareous and multisulcate.

India : Andamans. Red Sea and Mozambique to Japan and Fiji.

Naticarius pulicaria (Philippi, 1852)

(Pl. 37, fig. 13, 14)

Shell small, usually up to 11 mm in height, maximum height up to 16.5 mm, globose, neritoid, spire short, body whorl squarely rounded, rather flattened beneath the suture, surface smooth. Aperture ovate, columella calloused at the upper part, umbilicus circular and partly closed by the callus. Colour ashy-white, periphery ornamented with chocolate brown oblique blotches and narrow white band on the middle and lower part of body whorl, band bearing distantly placed chocolate-brown spots.

India : Maharashtra : Bombay; Tamil Nadu : Madras, Kanya Kumari. Indo-Pacific.

Tanea euzona (Recluz, 1844)

(Pl. 37, fig. 16, 17)

Shell small, up to 25 mm in length, thick and globose, spire low. Aperture semioval, funicle tongue shaped and enters the umbilicus obliquely. Shell surface smooth and ornamented with fine, closely arranged, wavy orange brown lines and three spiral zones of alternating white and orange brown arrow-shaped marks, umbilicus white. Operculum with two marginal ribs.

India : Tamil Nadu : Gulf of Mannar (Tuticorin); Pondicherry, Andamans, offshore, 30 m. Persian Gulf and Mozambique to Japan and Philippines.

Subfamily POLINICINAE

Neverita alba (Linnaeus, 1758)

(Pl. 38, fig. 9, 10)

Shell moderately large, up to 40 mm in length, thick, ovate and laterally compressed, spire depressed and exerted, body whorl very large. Aperture semioval, almost extending up to the spire, very thick, tongue shaped parietal callus in the middle of the columella coalescing with the funicle and posteriorly narrow, funicle broad and fills the centre of the umbilicus leaving a narrow groove anteriorly and deep umbilical depression posteriorly. Surface shining and smooth with obsolete growth striae. Colour cream, umbilical area and spire white, interior of aperture dull white. Operculum corneous and dark reddish-brown.

India : Tamil Nadu, Pondicherry, Andamans, not common. Indo-West Pacific.

Neverita pesselephanti (Link, 1807)

(Pl. 38, fig. 11, 12)

Shell small, up to 30 mm in length, thick, not much compressed laterally, spire low and conical. Aperture large and lunar ovate, umbilical groove very deep and less circular, funicle

not much conspicuous, terminates in a ledge-like callus pad. Colour white or cream, sometimes with a faint yellowish line around the base, umbilical area, nuclear whorls and interior of aperture white, funicle finely ridged. Operculum chitinous and dark reddish-orange.

India : Tamil Nadu, Pondicherry, common. Red Sea and Mozambique to Japan and Australia.

Polinices (Glossaulax) didyma (Roeding, 1798)

(Pl. fig.)

Shell moderately large, up to 57 mm in length, thick, body whorl large and inflated, broader than high with a depressed spire, surface smooth and glossy. Aperture large and semioval, columella with a large transversely expanded curved callosity divided into two by a transverse groove, posterior portion large and fuses with the body whorl covering the umbilicus, anterior part smaller and free, funicle overlapped by the callosity, umbilicus a wide excavated angular opening. Surface uniformly pale brownish or grayish, callosity and interior of aperture deep chestnut.

India : Gujarat, Maharashtra, Tamil Nadu, Pondicherry, Andhra Pradesh, Orissa, West Bengal, common, intertidal to 100 m. Indo-West Pacific.

Synonyms : *Natica chemnitzii* Recluz, 1843

Neverita bicolor Philippi, 1849

Natica lamarckiana Reeve, 1855

Polinices (Mammilla) melanostoma (Gmelin, 1791)

(Pl. 38, fig. 5, 6)

Shell of medium size, up to 35 mm in length, not thick, pyriformly ovate, spire short with a blunt apex. Aperture large, oblong semilunar, parietal callus folded partly covering the wide and deep umbilicus. Surface shining with fine growth striae. Colour white or steel gray with three brownish gray spiral bands on the body whorl, parietal callus dark chocolate brown, interior of aperture pale brown. Operculum corneous and dark reddish brown.

India : Lakshadweep : Minicoy Island; Tamil Nadu, Pondicherry (common), Andamans, rare. South Africa to Japan and Hawaii.

Polinices (Mammilla) flemingiana (Recluz, 1844)

(Pl. 38, fig. 7, 8)

Shell small, up to 15 mm in height, aperture obliquely elongated, a deep anterior umbilical groove, operculum corneous with a dark brown zone along the outer margin.

India : Andamans. Indo-West Pacific.

It resembles *P. mammilla* but can be distinguished by the broader aperture and umbilical groove. Its outline is not oblique as in *P. mammilla*.

***Polinices (Mammilla) sebae* (Recluz, 1844)**

Shell small, up to 10 mm in height, thin, quad angularly ovate, spire depressed, body whorl very large and inflated. Aperture large and squarely ovate, Columella broadly reflected almost covering the umbilicus. Sculptured with distinct growth lines intersected by conspicuous spiral striae. Colour white, body whorl with two rows of quadrate brown spots umbilical area dark chest nut coloured.

India : Maharashtra : Bombay; Tamil Nadu : Tuticorin; Andamans. East Africa and Natal to Philippines.

Synonym : *Natica zanzibarica* Recluz, 1844 (Kilburn, 1970).

***Polinices (Polinices) mammilla* (Linnaeus, 1758)**

(Pl. 38, fig. 3, 4)

Shell of medium size, up to 35 mm in length, thick, pyriformly ovate, spire low and bulbous. Aperture semilunar, umbilical area filled with broad and thick funicle. Surface smooth except for fine growth striae. Colour ivory white, often with yellowish tinge on the funicle. Operculum chitinous, light brown with a dark brown zone near the columellar edge.

India : Maharashtra, Goa, Kerala, Lakshadweep, Tamil Nadu (common), Pondicherry (common), Orissa, Andamans, common in shallow waters. Indo-West Pacific.

Synonym : *Mamillaria tumidus* Swainson, 1840.

Kabat (1990) discussed the synonym of this species and concluded that *Polinices mammilla* should be "restricted to the white shelled, closed umbilicus forms"

Subfamily SININAE

***Eunaticina (Eunaticina) coarctata* (Reeve, 1864)**

(Pl. 39, fig. 3, 4)

Shell small, up to 15 mm in length, thick, globosely ovate, spire low, whorls slopingly contracted above and swollen towards base, suture a little distinct. Aperture widening anteriorly, parietal callus at the posterior part of the columella, a transverse groove in the middle separating the callus into two, posterior part fuses with the body whorl, anterior part

free and extends into the deep and semicircular umbilicus. Surface spirally grooved and crossed by axial growth striae. Colour dull brown, umbilical area, columella and interior of aperture white.

India : Tamil Nadu, Andamans. Elsewhere : Singapore.

Eunaticina (Eunaticina) linneana (Recluz, 1843)

(Pl. 39, fig. 1, 2)

Shell small, up to 20 mm in length, thin, broadly ovate, with low conical spire and deep sutures. Aperture large and wider at the base, columella almost straight, parietal callus narrow, posteriorly reflected over the umbilicus and gradually narrowing down anteriorly, umbilicus open and deep, without an internal funicle. Sculptured with about 50 fine, irregularly spaced spiral grooves crossed by finer and close-set axial growth lines. Colour dull brown, operculum corneous and light brown, smaller than the aperture.

India : Tamil Nadu : Gulf of Mannar, not common. Japan and Fiji to Natal (South Africa).

The species has often been misidentified as *Eunaticina papilla* (Gmelin).

Synonym : *Sinum tumescens* (Reeve, 1864) : Mookherjee, 1985.

Eunaticina (Eunaticina) papilla (Gmelin, 1791)

(Pl. 39, fig. 5, 6)

Shell small, up to 10 mm in height, auricular in shape, spire exerted, a shallow groove between spire and body whorl. Aperture large, ovate, posteriorly narrow, columella with weak callus. Sculptured with fine, regular evenly spaced spiral grooves intersected by finer close set transpiral growth lines.

India : Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar—very common; Madras, Tranquebar, Indo-Pacific.

Sinum delesserti (Recluz, 1843)

(Pl. 39, fig. 7, 8)

Shell small, up to 15 mm in length, thin, ear-shaped, with a low and suppressed spire. Aperture large and elongate, parietal callus thin and obscures the umbilicus. Sculptured with evenly spaced, coarse spiral threads crossed by axial growth striae. Colour reddish-brown with subsutural white area on the shoulder of the body whorl, aperture and callus white. Operculum corneous.

India : Orissa : False point; Tamil Nadu. Madagascar to Philippines.

***Sinum haliotoideum* (Linnaeus, 1758)**

(Pl. 38, fig. 15, 16 and Pl. 39, fig. 9, 10)

Shell small, up to 30 mm in length, thin and translucent, compressed and ear-shaped, spire low. Aperture large, elongate, umbilicus closed by parietal callus, outer lip thin. Sculptured by fine wavy spiral threads and obsolete growth lines. Colour ivory white or white.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu, offshore. Madagascar and Natal (South Africa) to Indonesia and Philippines.

Synonym : *Sigaretus planatus* Recluz, 1843

Sigaretus planulatus Recluz, 1843.

***Sinum laevigatum* (Lamarck, 1822)**

(Pl. 39, fig. 11, 12)

Shell small, up to 22 mm in length, somewhat similar to *S. neritoideum* but more compressed. Umbilicus closed by parietal callus. Sculpture different from that of *S. neritoideum*, flat-topped major spiral ridges separated by fine single or paired intermediary threads, often becoming wavy. Colour yellow, apex purple blue.

India : Andamans, rare. Mozambique to Indonesia.

Not known from India's mainland coast.

***Sinum neritoideum* (Linnaeus, 1758)**

(Pl. 38, fig. 13, 14)

Shell of medium size, up to 40 mm in length, thick and depressedly ovate, spire reduced, body whorl large and inflated, not much compressed as in the other species. Aperture large and broadly ovate, columella slightly arched, with callus deposit reflected slightly over the preceding whorl, outer lip thick, umbilicus closed. Sculptured with close-set well-developed spiral ridges and fine axial growth lines. Colour yellowish brown, columella and interior of aperture white, rather glossy, apex purple brown.

India : Gujarat, Maharashtra : Bombay; Tamil Nadu : Madras, Tranquebar, Gulf of Mannar; Orissa : Chandipore, Puri; mainly offshore, not common. Arabian Sea to Malaysia, Indonesia to Japan.

The following species were also reported from India : *Natica (Natica) arachnoidea* (Gmelin, 1791)—Andamans. *Neverita effusa* (Swainson, 1822)—Gulf of Mannar, Tamil Nadu. *Polinices (Mammilla) simiae* (Deshayes)—Nicobars.

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Family TONNIDAE

Tun Shells

Shell is small to very large in size, up to 200 mm in length, thin and light weight, capacious, spire short and less elevated, body whorl large and inflated, ovoid or globular. Aperture is very wide, and bears a large anterior siphonal canal, anal or posterior canal either absent or insignificant, outer lip margin fluted or denticulate, columella often twisted and bears more or less strong callosity, umbilicus covered by callosity or sometimes open. Sculpture consists of mainly raised spiral ribs separated by grooves, true varices and axial sculpture absent. Operculum is absent.

Head bears long filiform tentacles, with eyes at their outer bases. Foot is large, pointed posteriorly and truncated anteriorly. Mantle cavity contains a monopectinate ctenidium and bipectinate osphradium. Proboscis is extensible with a suction cup at the tip formed out of terminal lips.

Radula is taenioglossate (2-1-1-1-2). Digestive system consists of a well-developed buccopharyngeal gland, an accessory gland and a long duct along the oesophagus. Nervous system is zygoneurous.

Sexes are separate. Male bears a large penis and often with an accessory papilla. It possesses an open seminal groove formed out of the male pallial gonoduct. Eggs are oval and transparent. These are laid in masses of broad ribbons. Free-swimming planktonic veligers can survive for 6-8 months.

Tun Shells prefer sandy habitats from subtidal to deep waters. Their prey mainly consists of echinoderms especially holothurians, bivalves, crustaceans and fish. About 50 species are known worldwide. The family includes three genera, namely *Tonna*, *Maleum* and *Eudolium*. The former two, represented by the following species, occur in India.

***Tonna cepa* (Roeding, 1798)**

(Pl. 41, fig. 7)

Shell large, up to 110 mm in length, globose and thin, whorls convex, sutures deeply canaliculated, base of the shell broad. Aperture wide, outer lip thick, columella without parietal callus and twisted on its lower part. Sculptured with five to six spiral ribs on the early whorls, and about sixteen to seventeen broad, flat ribs on the body whorl divided by narrow and shallow grooves. Cream or light fawn in colour, ornamented with uneven light brown or purple brown markings, aperture brown within, with white columella.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands. Indo- Pacific. Not common in the Indian Ocean.

Synonym : *Tonna olearium* (Bruguere, 1789).

***Tonna cumingii* (Reeve, 1849)**

(Pl. 41, fig. 5)

Shell large, up to 75 mm in length, solid and globose, spire elevated. Aperture slightly wide, outer lip thick and fluted, columella with a slightly twisted and sharp callus and an open umbilicus. Sculptured with numerous close-set, flat, spiral ribs, about 20 on the body whorl and 7 on the penultimate whorl, containing a single thread in between, ribs seen through the aperture. Colour brown, decorated with white chevron- shaped markings.

India : Tamil Nadu, Pondicherry, not common. Indo-Pacific.

***Tonna dolium* (Linnaeus, 1758)**

(Pl. 41, fig. 9)

Shell very large, up to 150 mm in length, thin, globose, sutures canaliculated, spire low, and body whorl inflated. Aperture very wide, showing spiral depressions corresponding to the ribs on the dorsal surface, outer lip simple, thin and fluted, columella almost straight, without a parietal shield, twisted conspicuously on the basal part, umbilicus open and deep. Sculptured with broad, flat, raised, widely spaced spiral ribs, two to three on the penultimate whorl and about thirteen to fourteen on the body whorl, with threads in the intermediate spaces. Colour white to cream, ornamented with rectangular or quadrate orange brown spots on the ribs, apex and aperture brown.

India : East Coast, very common. Indo-West Pacific, common in the Indian Ocean.

Synonym : *Tonna maculatum* Lamarck, 1845

***Tonna perdix* (Linnaeus, 1758)**

(Pl. 41, fig. 8)

Shell large, up to 110 mm in length, elongate-ovate, narrow, thin, spire strongly elevated and apex sharply pointed; narrow and obliquely inclined body whorl, whorls with rounded shoulders, distinct but not very deep sutures. Aperture wide and elongate, outer lip slightly thickened, but thin and fluted, columella with a small parietal callus, deeply umbilicate, siphonal canal twisted towards aperture. Sculptured with eight on the penultimate and about twenty flat, spiral ribs separated by narrow and shallow grooves on the body whorl. Colour brown with ribs mottled with white, columella and callus white, interior brown, outer lip margin dark brown, nuclear whorls yellowish-brown.

India : Tamil Nadu, Andaman and Nicobar Islands, coral reefs. It has a very large foot compared to the shell. Indo- Pacific.

***Tonna sulcosa* (Born, 1778)**

(Pl. 41, fig. 1-3)

Shell large, up to 110 mm in length, elongate oval, slightly solid, sutures moderately deep, spire short and conical, base of the shell produced. Aperture wide, outer lip slightly thickened and denticulate, columella with a small, thin parietal shield, lower half slightly twisted. Sculptured with broad, flat and close-set spiral ribs, about 6 to 8 on the penultimate whorl and 18 to 20 on the body whorl, intercostal spaces shallow and smooth, but often with a single thread in some. Colour white with four or five brown bands on the body whorl, aperture white, apex dark purple. The colour bands readily distinguish this species from others.

India : Tamil Nadu, Andhra Pradesh, Orissa. Indo-West Pacific.

Synonym : *Tonna fasciatum* Bruguiere, 1789

Dolium varicosum Preston, 1910

***Tonna tessellata* (Lamarck, 1816)**

(Pl. 41, fig. 4)

Shell large, up to 120 mm in length, solid and heavier than in *T. dolium*, spire elevated, consists of 5 ½ whorls. Aperture wide, outer lip thick, wavy or fluted, with about 12 pairs of denticles on the inner edge, lower part of the columella with a parietal callus partly covering the umbilicus, columella twisted, with a groove running from the umbilicus, siphonal canal recurved. Sculptured with a number of raised, rounded ribs, three on the penultimate whorl, 13 to 14 on the body whorl, the intercostal spaces smooth. Cream coloured, the ribs marked with numerous alternate spots of white and brown, outer lip, parietal callus white.

India : Tamil Nadu : Gulf of Mannar; Andamans, not common. Indo-West Pacific.

It is often confused with the common *T. dolium* but can be differentiated by its thicker shell, numerous regularly spaced spiral ribs without intermediate threads, thickened and denticulate outer lip.

***Malea pomum* Linnaeus, 1758**

(Pl. 41, fig. 6)

Shell moderately large, up to 65 mm in length, solid with a low spire. Aperture narrow, outer lip broad and widens towards the base, with ten strong, elongated teeth on the inner side, columella with a white, smooth callosity on the upper part; with four to five plications on the lower half, a siphonal notch, umbilicus closed by parietal callus. Sculptured with smoothly rounded spiral ribs, three on the penultimate whorl and twelve on the body whorl, interspaces narrow.

Cream coloured with white squares on the ribs, interior of aperture orange brown with white callus and outer lip.

India : Andaman and Nicobar Islands, sandy substrates in coral reefs. It has a large foot. Indo-Pacific.

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Family FICIDAE

Fig Shells

Shell is medium to large in size, thin, fig shaped with low spire and a large, long body whorl. Aperture broad and long, with a long drawn-out anterior canal, outer lip simple and not thickened, columellar margin arcuate and without a parietal shield. Sculptured by spiral lirations crossed by fine axial striations giving the shell a cancellated surface. Operculum is absent.

Head is long and narrow, with a pair of long, pointed filiform tentacles. Eyes are situated at the outer side of base of tentacles. Foot is very broad and irregularly rounded posteriorly, and on the anterior side there are recurved lateral tentaculate processes. Mantle is reflected over the shell and the mantle folds are beautifully veined. Siphon is long and narrow. A large monopectinate ctenidium and a smaller and narrow bipectinate osphradium are present in the mantle cavity. A long proboscis is with unhooked jaw plates. A taenioglossate radula (2-1-1-1-2) and simple but large buccopharyngeal glands are present.

Sexes are separate and can be differentiated by their shells, which are longer in females than in males. The latter possess a penis and a closed pallial sperm duct. Eggs are deposited in stacked masses.

Fig Shells occur on sandy and muddy bottoms up to 200 m of depth. These are carnivorous and feed on echinoderms, especially sea urchins. These secrete acid, which soften the sea urchin test facilitating the radula to drill a hole. The proboscis then devours the flesh from inside. The family is monogeneric with a few species distributed at subtidal depths, mostly in the Indo-Pacific.

Ficus ficoides (Lamarck, 1822)

(Pl. 43, fig. 5, 6)

Shell of medium size, up to 50 mm in length, rather thin, spire almost flat. Aperture more elongated, outer lip thin and slightly convex, columella almost straight with a curve in the centre, siphonal canal longer and more slender than in *F. variegata* but shorter than in *F. gracilis*. Sculptured with about 35 strong spiral cords enclosing three finer threads in each of the inter space, axial cords cross the spiral cords giving a strongly netted shell surface. Colour light brown, ornamented with 4 or 5, narrow, ivory coloured bands which bear widely spaced brown dots or dashes, large irregular brown blotches on the shell surface, interior of aperture white with a violet tinge near the outer lip, becoming brown towards the interior.

India : Tamil Nadu, Pondicherry, not common.

Synonym : *Ficus reticulata* Reeve, 1847

Ficus gracilis Sowerby, 1825

(Pl. 42, fig. 1–4)

Shell large, up to 100 mm in length, thick, with slightly elevated spire and elongate body whorl. Aperture long and wide, outer lip slightly thickened and almost straight, columella almost straight with a curve in the center, long and broad siphonal canal. Sculptured with widely spaced strong, flat spiral cords and smaller axial cords. Colour light brown, ornamented with many axial, darker brown wavy lines, aperture chestnut brown,. With pale blue-gray outer lip and columella.

India : West Bengal, Orissa, Andhra Pradesh, Pondicherry (very rare), Nicobars. Indo-Pacific up to 100 m.

Synonym : *Ficus dussumieri* Chenu.

Ficus investigatoris E. A. Smith, 1906

(Pl. 43, fig. 1–4)

Shell large, up to 80 mm in length, thin, spire large and elevated, body whorl narrowly elongate. Aperture narrower than in the other species of the genus, outer lip thin, siphonal canal short and broad. Sculptured with narrow and raised spiral cords and obsolete axial cords, colour uniformly dull brown without any ornamentation.

India : Lakshadweep, Orissa, Andaman Sea, rare. Indian Ocean, 185 m.

The species differs from others in its shape, raised spire and in being drab coloured.



Fig. 30. *Ficus* with animal.

***Ficus variegata* Roeding, 1798**

(Pl. 42, fig. 5-8)

Shell large, up to 90 mm in length, more globose than in the preceding species, spire low, body whorl more globose. Aperture broad, outer and inner lips moderately thick. Siphonal canal short and broad. Sculpture quite distinct, spiral ridges high with deep grooves in the interspaces, axial ridges obsolete to pronounced giving the shell surface a delicate or strongly netted appearance, often giving a beaded appearance at the intersection of spiral and axial ridges. Colour light brown with white bands ornamented by large blotches.

India : Lakshadweep, West Bengal, Orissa (very common), Andhra Pradesh, Tamil Nadu, Pondicherry, Nicobar Islands. Indo-Pacific.

Synonym : *Ficus ficus* of authors

Ficus subintermedia (Orbigny, 1852)

Pyrula sewelli Prashad, 1927.

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Family CASSIDAE

Helmet Shells, Bonnet Shells

Shell is moderate to rather very large in size, some attaining 380 mm in length, solid and heavy, porcelaneous, with large body whorl and moderate to short spire. Aperture is narrow and elongated, with a short oblique anterior canal and often a posterior canal of various sizes, outer lip thickened and with blunt teeth in the majority, columella with a parietal shield and plications. Shell surface may be smooth or with variously developed spiral and axial ridges, and often nodulose at the shoulder. Operculum is thin and horny, brown and semicircular with an acentric nucleus at its inner margin.

Head is large and bears moderately long, filiform tentacles; eyes situated on the protuberances at the outer bases of tentacles. Foot is large and almost rounded at both the extremities. A monopectinate ctenidium and a bipectinate osphradium are present in the mantle cavity. A large pleurembolic proboscis, which is cylindrical and extensible, helps in the capture of the prey. Radula is taenioglossate (2-1-1-1-2) and bears 88-220 rows of teeth. Digestive system consists of buccopharyngeal or salivary glands and neurotoxic acid-secreting gland.

Sexes are separate. In some sexual dimorphism is well noticed. In males shell is smaller and bear fewer and elongated sculptural knobs, and a prong like penis on the right side of the head. Eggs are laid in tower-like capsules and each capsule may contain up to 300 eggs. Some of these eggs act as 'nurse eggs' and provide nourishment to other eggs to develop and hatch into veliger larvae that have a long planktonic life.

Majority of the species occur in sandy substrates from low tide level to depths. They feed upon echinoderms. About 60 species under 10 genera are known worldwide, four genera and 9 species are known from Indian Seas.

Subfamily CASSINAE

Cassis cornuta Linnaeus, 1758

(Pl. 44; fig. 1, 2 and Frontis piece)

Shell very large, up to 350 mm in length, very solid and heavy, spire short and consists of seven whorls. Aperture comparatively narrow, outer lip thick and wide with a recurved edge, twelve blunt teeth on the inner margin, columella with about fifteen plaits on the lower two-thirds, narrowly umbilicate, a large parietal shield almost obscures the body whorl when looked from the ventral side, siphonal canal twisted and turned up vertically. Sculptured with two broad, strong spiral ridges and several small, with long, narrow pits between them, horn-like knobs on the shoulder. White with light brown shading and sparse brown spots, outer lip and

teeth white with brown 'squares', columella, inner area of shield orange brown, rest of shield pinky-white.

India : Tamil Nadu (15-20 m), Pondicherry (rare), Andaman and Nicobar Islands. Indo-Pacific.

It is commonly called as 'King Shell' Males are generally smaller than the females.

***Cypraecassis rufa* Linnaeus, 1758**

(Pl. 45, fig. 2 Frontis piece 7, 8)

Shell very large, up to 180 mm in length, solid, spire low with pointed apex, whorls with angulated shoulders. Aperture narrow, columella lirate and toothed, a large parietal shield, outer lip thickened, broad, recurved and with twenty-two elongated teeth. Siphonal canal turned up vertically, with a posterior canal. Body whorl sculptured with three to four rows of blunt knobs, top row biggest and decrease downwards, the base with spiral cords and bands, columella red, teeth white, interstices dark brown, parietal shield pink brown.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-West Pacific.

It is popular as pine apple shell or Queen shell among shell dealers in Andamans.

Subfamily PHALIINAE

***Phalium areola* (Linnaeus, 1758)**

(Pl. 45, fig. 1, 3)

Shell large, up to 90 mm in length, whorls not angulated, spire sharply pointed. Outer lip thick and recurved, broader especially towards the base, with 22 widely separated teeth, lower half of columella and parietal shield with irregular coarse, spiral ridges, anterior canal deep and slightly deflected to the left. Spire and shoulder of penultimate whorl cancellate, without any nodes, body whorl smooth and glossy with a well-developed varix. Colour white with 5 rows of rhomboidal brown spots and outer edge of shield with pink-brown tinge.

India : Orissa, Andhra Pradesh, Tamil Nadu, Pondicherry (uncommon), Andamans. Central Indo-Pacific.

***Phalium glaucum* (Linnaeus, 1758)**

((Pl. 44, fig. 3, 4 and Pl. 45, fig. 4)

Shell large, up to 120 mm in length, solid, strongly inflated body whorl and a short conical spire. Outer lip thickened, with 25 teeth on the interior and three or four strong and sharp

spines at the base, columella with a prominent callous shield and numerous irregular plications, umbilicus narrow and deep, siphonal canal turned up vertically. Apical whorls with sharply angulated shoulders and spiral beads, body whorl expanded and smooth with a spiral row of beads and obsolete short folds on the presutural ramp. Colour grayish, aperture dark brown within, outer lip edge with about five broad brown bars, columella and shield creamy pink to white.

India : Andhra Pradesh, Tamil Nadu, Pondicherry, common. Indo-Pacific.

Phalium (Semicassis) bisulcatum bisulcatum (Schubert and Wagner, 1829).

(Pl. 45, fig. 5)

Shell moderately large, up to 70 mm in length, globose, spire short and depressedly conical, whorls convex with small, widely-spaced strong or weak teeth, parietal shield prominent and slightly rugose, columella with a few transverse ridges on the upper part and irregularly plicated on the lower part. Sculptured with spiral cords and axial lirae on early whorls and spiral grooves on the last whorl. Colour creamish with five rows of more or less prominent squarish light brown spots, outer lip, aperture and parietal shield white, outer lip with or without five groups of dark brown marks.

India : Orissa, Tamil Nadu, Pondicherry, very common, Andamans. Indo-West Pacific.

Phalium (Semicassis) faurotis (Jousseaume, 1888)

(Pl. 45, fig. 7)

Shell of medium size, up to 40 mm length, thin, globose. Aperture narrowly elongate, outer lip thick, with about twenty teeth, columella with a thin shield, three to five folds at the base and two plications on top, umbilicus narrow, deep. Sculptured with distinct regularly spaced spiral grooves, spire whorls with fine axial riblets within the grooves. Colour cream or pale brown with five spiral rows of rectangular, reddish brown blotches, spire whorls dark purple, outer lip ornamented with five broad brown bars.

India : Andamans. Western Indian Ocean.

Phalium bandatum bandatum (Ferry, 1811)

(Pl. 45, fig. 9)

Shell large, up to 120 mm in length, elongate, spire high and concave, outer lip thickened and recurved with twenty elongate teeth, largest centrally, columella with five small folds anteriorly, parietal shield strongly folded with raised lirae. Sculptured with beaded spiral cords

on the early whorls and faint striae on the later whorls; small knobs on antepenultimate whorl, five yellowish transverse bands with darker yellowish brown bars, aperture dark brown within the outer lip and columellar shield yellow or yellowish orange, outer lip with six purple-brown spots.

India : Indian Seas, no specific locality, no recent collection. Mainly West Pacific.

Synonym : *Cassis coronulata* Sowerby, 1825

***Casmaria erinaceus erinaceus* (Linnaeus, 1758)**

(Pl. 45, fig. 8)

Shell large, up to 70 mm in length, spire moderate, shoulders rounded. Aperture broad, outer lip thickened, recurved and smooth except for five or six small, sharp spines anteriorly, columella smooth with two folds anteriorly. Shell surface smooth, some times with nodulose shoulders. Cream coloured, with a purple tinge, aperture white, purple-brown blotches on outer lip, body whorl with faint yellowish-brown squares, yellowish-brown marks below suture.

India : Andaman and Nicobar Islands. East Africa to Polynesia.

***Casmaria ponderosa ponderosa* (Gmelin, 1791)**

(Pl. 45, fig. 6)

Shell of medium size, up to 50 mm in length, elongately ovoid, spire moderate and apex pointed, whorls moderately convex and evenly rounded. Aperture narrow, outer lip thickened and reflected, with seven, rather widely spaced, short and pointed tubercles, inner margin with numerous small teeth. Shell surface smooth without spiral ribs, grooves or varices, with a row of blunt nodules on the shoulder of the body whorl. Colour cream, with two pale brown spiral bands, dark brown marks below suture and on the anterior part of the body whorl, dark-brown oblong marks on the thickened, ridge-like margin of the outer lip.

India : Lakshadweep: Minicoy Island; Tamil Nadu: Gulf of Mannar; Pondicherry (rare), Andamans. Red Sea to Polynesia.

Shell is less slender than in the preceding species, axial folds on the body whorl never reach the base, outer lip denticulate along its whole length and has a bottom row of brown spots.

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Family RANELLIDAE

Triton Shells

The family name Ranellidae has been adopted recently replacing the more familiar name Cymatiidae (Beu and Cernohorsky, 1986).

Shell size ranges from 30 mm to 400 mm in height, thick, fusiform or ovate-ventricose. Protoconch is large and smooth with five to six whorls. Tritons are distinguished by their thick, hairy or fibrous periostracum. Body whorl is large with a rounded aperture. Outer lip is thickened with undulate outer margin and denticulate inner margin. Columella has a parietal callus that obscures the umbilicus. Anterior siphonal canal is short to long, wide or narrow and often recurved; anal canal is obsolete or absent. Sculpture is characterised by strong, raised spiral ribs, heavy knobs and varices. Operculum is of various shapes, thick and corneous with acentric nucleus.

Head bears two filiform tentacles, which have eyes on their outer bases. Foot is short and truncated posteriorly. Mantle cavity consists of a monopectinate ctenidium and a bipectinate osphradium. Mantle edge bears a papilla, an anterior incurrent siphon and a posterior excurrent siphon. Proboscis is stout and extrusible. Digestive system consists of a hypobranchial gland, taenioglossate radula (2-1-1-1-2), a pair of acid secreting salivary glands, and a style sac.

Sexes are separate. Male possesses a large, flattened penis and an open pallial gonoduct. Female has a closed pallial oviduct, albumen and capsule glands. Eggs are laid in large capsules. There is a free-swimming veliger stage.

Tritons occur on sandy or rocky habitats from shallow intertidal zone to deep sea of tropical regions. These are carnivores feeding on other snails, clams, starfishes and sea urchins. About 130 species are known worldwide, of which 20 are reported from India.

Subfamily CYMATIINAE

Charonia tritonis Linnaeus, 1758

(Pl. 46, fig. 5, 6)

Triton's Trumpet. Shell very large, up to 300 mm in height, spire high and pointed, body whorl elongate. Aperture very large, outer lip flaring, about 10 to 12 spiral ribs extending on to the interior, columella concave, strongly and coarsely lirate, umbilicus narrow, siphonal canal very short. Sculptured with coarse spiral and axial ribs, spiral ribs below the suture beaded, two such ribs on earlier whorls and three on the body whorl, ribs flat and broad with a small narrow rib in the interspaces. Shell creamy white with purple and brown markings on spiral ribs, lip pinky-white, interior of aperture orange, columella orange-pink with purplish brown between the lirae.

India : Lakshadweep, Nicobars, rare. Indo-Pacific.

It usually occurs among coral reefs and feeds on starfishes, including the crown-of-thorns sea stars, *Acanthaster planci* that feed on the coral polyps. Hence it is considered as a key species in the reef ecosystem. Over collection has been a threat to the survival of this species. It is listed as an endangered species in the IUCN Invertebrate Red Data Book (1984). In Nicobar Islands, population seems to have been reduced due to over collection by shell dealers who can easily fetch around Rs. 2000/- per a single shell.

***Cymatium (Gelagna) succinctum* (Linnaeus, 1771)**

(Pl. 48, fig. 1)

Shell of medium size, up to 35 mm in length, light, narrowly elongate with six inflated whorls, body whorl gradually leading to the spire. Aperture small, outer lip expanded, its outer edge with a small varix and interior channelled, columella smooth, siphonal canal elongate and straight. Sculptured with smooth and rounded spiral cords on the body whorl and seven on the penultimate whorl, cords separated by smooth and wide channels. Colour pale brown, spiral cords red, aperture, outer lip and columella white.

India : Andaman and Nicobar Islands, not common. Indo-Pacific.

***Cymatium (Gutturnium) muricinum* (Roeding, 1798)**

(Pl. 47, fig. 1)

Shell large, up to 75 mm in length, solid, spire high, body whorl higher than broad and proportionately of the same height as the spire. Aperture moderately large, outer lip with strong varix, with seven teeth arranged in two rows separated by a groove, upper row of teeth stronger, columella with parietal shield and with wrinkles at its basal part, siphonal canal moderate in an angle of 45°. Sculptured with coarse spiral and axial cords, six to seven main cords on the body whorl and three on the penultimate whorl, with three varices and rows of axial nodules in between, colour dull brown with dark brown mottling, aperture, columella and lip white.

India : Indian Seas, Andaman and Nicobar Islands, no recent collection. Indo-West Pacific, Caribbean Sea.

***Cymatium (Linatella) cumaceum* Lamarck, 1816**

(Pl. 47, fig. 5)

Shell small to medium in size, up to 40 mm in length, thinner than in other species of the family, spire moderately elevated, conical and with smooth protoconch, whorls feebly angulated above. Aperture proportionately broader, outer lip flaring outward, the ribs ending as teeth on the margin, numbering about fifteen, columella with very thin callus and almost smooth, umbilicus

narrowly open, anterior siphonal canal moderately produced and rather strongly twisted. Sculptured with evenly spaced, flattened, smooth and shining ridges, grooves narrow, shallow and smooth. Colour pale brown.

India : Tamil Nadu.

Synonym : *Cassidaria cingulata* Lamarck, 1822

Cymatium (Lotorium) lotorium (Linnaeus, 1758)

(not figured)

Shell large, up to 70 mm in length, thick, spire moderately elevated and turreted, body whorl wide above and abruptly narrow below, whorls strongly and angularly shouldered. Aperture narrow and oval, outer lip strongly thickened, with seven teeth on the inner edge, columella almost straight, with heavy callous rib at the upper part, wrinkles in the central part, and a small rib at the base above the siphonal canal, siphonal canal narrow and elongate, with only a slight twist. Sculptured with thick and raised varices, two major on the body whorl strong and each traversed by deep transverse depressions, additional transpiral ribs between the varices strongly knobbed on the shoulder. Colour brownish, ornamented with dark brown transverse bands on the varices.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific.

Cymatium (Monoplex) nicobaricum Roeding, 1798

(Pl. 47, fig. 2)

Shell moderately large, up to 50 mm length, spire high and elevated, body whorl expanded. Aperture oval and small, outer lip with strong varix and seven pairs of elongate teeth on the interior, columella lirate, siphonal canal more elongate than in *C. pileare*. Sculptured with nodulose spiral ribs and fine threads in the interspaces, with strong varices, three to five large knobs between the varices on the shoulder. Ash coloured with red markings and indistinct cream bands, aperture orange yellow, outer lip and teeth white. Varix dark gray and white.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific, Atlantic.

Cymatium (Monoplex) pileare Linnaeus, 1758

(Pl. 47, fig. 3)

Shell large, up to 120 mm in length, spire high and elongate, body whorl narrow and tapering below. Aperture narrow and ovate, outer lip thick with strong varix and seven to eight pairs of teeth on the inner edge, columella with very strong, whitish, wrinkle-like ridges, siphonal canal almost closed and slightly twisted. Sculptured with close-set, strong, finely beaded, spiral ridges, alternate ridges stouter and traversed by a median groove, interspaces between the ridges traversed

by spiral threads, varices five to seven, two on either side of the aperture strongly developed. Aperture, outer lip and columella deep red or pale orange. Colour light and dark tan, varices darker brown with white bands.

India : Gujarat: Porbandar; Lakshadweep, Tamil Nadu: Gulf of Mannar (Pamban); Andaman and Nicobar Islands. Indo-West Pacific.

Cymatium (Monoplex) vespaceum (Lamarck, 1822)

(Pl. 47, fig. 4)

Shell of medium size, up to 35 mm in height, elongate-ovate, spire narrow and elevated with a pointed apex, body whorl longer than spire, sutures deep. Aperture narrow, outer lip outer margin with a varix, broad, often paired teeth on the inner side, columella with strong lirations throughout, siphonal canal short. Sculptured with strong spiral cords crossed by axial riblets, two varices on either side of the shell, shoulder region well angulated by prominent nodules. Colour chocolate brown with white spiral bands, one on each whorl, outer lip with white and brown bands.

India : Lakshadweep, Tamil Nadu: Gulf of Mannar, not common. Indo-West Pacific.

Cymatium (Ranularia) tripum (Lamarck, 1822)

(Pl. 46, fig. 1)

Shell large, up to 70 mm in length, solid, spire elevated, body whorl almost as high as broad. Aperture narrow, outer lip with a strong varix and seven elongate teeth, columella without a shield, but with plications throughout and those on the basal part stronger than the rest, siphonal canal long and slightly twisted to left. Sculptured with coarse spiral ribs and axial cords, about seven prominent beaded ribs on the body whorl and three on the penultimate whorl, four strong knobs, almost varix-like on the shoulder, interspaces between the ribs with two to three finely beaded threads. Colour dull brown, aperture and lips purplish white, a whitish spiral band across the middle of the body whorl, white ridges on a purplish-white columella.

India : Tamil Nadu, Indian Seas, not common. Indo-West Pacific.

Subfamily RANELLINEAE

Biplex bozzetti (Beu, 1998)

(Pl. 48, fig. 4)

Shell small, up to 45 mm in height with strongly inflated whorls, dorsoventrally flattened, spire moderately high, anterior canal moderately long, sculptured with weak, spiral cords and

narrow ill-defined axial costae forming rounded nodules at their intersections with spiral cords; aperture oval with smooth inner lip and slightly thickened and reflexed outer lip, inside of aperture with indistinct spiral ridges, interstices with threads.

Distribution : India : Marine Survey Sta. 151 & 226, off Travancore, 355 m (194 fms), Tuticorin. Western and Northern Indian Ocean.

The species in India was earlier known under the name *Biplex perca*. Beu (1998) recognized four species, *Biplex bozzetti* (Indian Ocean), *Biplex perca* (Western Pacific), *Biplex pulchella* (North Australia and eastern Indonesia) and *B. pulchra* (Western Pacific). *B. pulchella* is the smallest. The other three species are recognized by relative spire height, aperture size, whorl diameter and sculpture.

***Biplex pulchra* (Gray in G. B. Sowerby, 1836)**

(Pl. 48, fig. 3)

Shell of medium size, up to about 40 mm in length, dorso-ventrally flattened, spire proportionately long and apex pointed. Aperture small and oval, outer lip with obsolete teeth, columella without a parietal shield, with a paired tooth at the upper part and obsolete plications on the rest, siphonal canal extended and slightly curved. Sculptured with expanded and flattened wing-like varices, spiral ridges with threads in between, axial ribs about twenty on the body whorl, blunt nodules at the intersection of axial and spiral ribs. Colour pale gray with whitish aperture and creamish nodules.

India : Orissa, Andhra Pradesh, Andamans. Its known distribution is western Pacific (Beu, 1998).

***Gyrineum (Gyrineum) natator* (Roeding, 1798)**

(Pl. 48, fig. 2)

Shell of medium size, up to 40 mm in length, dorso-ventrally compressed, thick and coarse looking, spire elevated and conical. Aperture round and small, outer lip with strong varix and seven, widely spaced ridge-like teeth, columella with a posterior tooth and obsolete plicae below. Sculptured with spiral cords, ten on the body whorl, four on spire whorls, axial ribs and fine threads with rounded nodules on the intersections, a pair of varices one on each side of the body whorl forming a continuous crest-like ridge from apex to the basal part of the shell. Colour grayish brown with dark brown bands and nodules, varices brown and white, aperture interior white, a white band around the body whorl.

India : Gujarat, Maharashtra, Goa, Tamil Nadu, Andhra Pradesh, Orissa, West Bengal. Northern Indian Ocean and Northwestern Pacific.

Subfamily PERSONINAE

***Distorsio (Distorsio) anus* Linnaeus, 1758**

(Pl. 48, fig. 6)

Shell large, up to 80 mm in length, irregularly inflated whorls and distorted shape, spire pointed. Aperture small and irregular in shape, outer lip thick with two rows of teeth, outer row consists of seven large teeth pointing outward, inner row consists of eight smaller teeth, a channel separates the two rows, columella very large with a wide central notch, parietal shield rugose with a fluted round edge, siphonal canal ridged on either side and sharply recurved. Sculptured with nodulose spiral ridges and axial riblets. Colour white, ornamented with brown spiral bands and blotches, aperture and parietal shield white, coated with pink and brown areas.

India : Nicobars. Indo-West Pacific.

***Distorsio (Distorsio) reticularis* (Linnaeus, 1758)**

(Pl. 46, fig. 3, 4 and Pl. 48, fig. 5)

Shell moderately large, smaller than in the preceding species, up to 50 mm length, whorls and shape not as irregular as in the preceding species. Aperture narrow and small, outer lip flattened, with ten, very small teeth on the outer edge and inner teeth at the end of the ridges crossing the lip, columella with thin parietal callus, long, strong plications on the basal part. Sculptured with spiral cords crossed by axial ribs forming sharp nodules at the intersections, often with a varix on the body whorl. Cream coloured, but teeth and aperture interior white.

India : Lakshadweep, Andhra Pradesh, Orissa, Andaman and Nicobar Islands. Indo-Pacific.

Synonym : *Distorsio reticulata* Roeding, 1798.

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Family BURSIDAE

Frog Shells

The common name 'Frog Shell' is due to its resemblance to a warty toad or a tree frog. Shell is small to very large in size, ranging from 12 mm to 250 mm in height. It is ovate, ventricate to flatly compressed and generally does not have a periostracum. It has an irregularly ovate aperture. Frog shells can be easily differentiated from other related families by the presence of a distinct posterior anal canal, which acts as an outlet for the discharge of wastewater. Anterior siphonal canal at the base of the aperture is generally small, but often may be elongate and twisted. Outer margin of outer lip is thickened and its inner margin denticulate. Columella is generally with a parietal shield that obscures the umbilicus, and bears plications on its margin. Sculpture consists of strong spiral and axial cords or threads and varices bearing knobs, which sometimes develop into spines. Operculum is thin or thick. It may be orange yellow or brown with a marginal or terminal eccentric nucleus.

Head bears two filiform tentacles, which have small eyes on their outer bases. Foot is short but strong. Mantle has papillae on its edge and possesses two short siphons, one for drawing in water (incurrent) and the other to act as an outlet for the waste (excurrent), which correspond to anterior siphonal and anal canals respectively seen on the shell. Mantle cavity has a monopectinate ctenidium and a bipectinate osphradium. The snails are carnivores and to help in the capture of prey they possess a very long, slender and pleurembolic proboscis. Digestive system consists of a taenioglossate radula (2-1-1-1-2), bulky and somewhat leaf-like salivary glands and a style sac. Anus opens half way in the mantle cavity.

Sexes are separate. Male possesses a flattened penis and an open pallial gonoduct. Female has closed pallial gonoduct, albumen glands and capsule glands. The eggs are laid in a gelatinous mass. Veliger larva has a long planktonic life.

The snails occur among rocks and coral reefs in the tropical seas. They are vermivores feeding on worms such as annelids, especially polychaetes, sipunculans. There are about 25 species under four genera living in subtropical and tropical seas. In India two genera *Bursa* and *Tutufa*, are represented by about 10 species, but only the following are dealt.

Bursa (Bufonaria) crumena crumena (Lamarck, 1816)

(Pl. 48, fig. 7)

Shell moderately large, up to 65 mm in length, shape somewhat similar to that of *B. rana*, broader with an elevated spire. Aperture obliquely ovate, outer lip broader and flatter supported by a varix as in *B. margaritula*, its inner margin denticulate, columella with a distinct parietal shield and strong plications at the bottom. Sculptured with fin-like, wider, and much thinner,

sharp-edged and spineless varices on either side, surface with finely nodulose spiral threads, two to three rows of short nodules on the body whorl and one on the penultimate whorl. Colour grayish dark brown, aperture and lips white, often tinged with dark brown.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu : Gulf of Mannar; Pondicherry (common). Indo-West Pacific.

***Bursa (Bufonaria) echinata* (Link, 1807)**

(Pl. 46, fig. 2 and Pl. 48, fig. 10)

Shell large, up to 75 mm in length, spire high, body whorl elongate, higher than broad, whorls slightly angulated. Aperture narrowly ovate, outer lip edge frilled, with strong irregular transverse teeth, columella with obsolete lirations, siphonal canal small and shallow. Sculptured with spiral cords and strong, elongated, outwardly directed spines, four spines on the outer lip edge, two very long and two small, arranged alternately. Colour uniformly pale brown.

India : East and West Coasts, Andaman and Nicobar Islands. Indian Ocean.

Synonym : *Bursa spinosa* (Lamarck, 1822)

***Bursa (Bufonaria) margaritula* (Deshayes, 1832)**

(Pl. 49, fig. 2)

Shell of medium size, up to 35 mm in length, thick, spire short, body whorl a little broader than high, whorls angulated in the middle. Aperture almost round, outer lip with fin-like outer edge and about fourteen denticles on the inner edge, inner lip thin and narrow, columella calloused and plicate, plications becoming prominent at the base, short and straight siphonal canal and a distinct anal canal. Sculptured with strong rounded varices traversed by coarsely granular transverse ridges, the varices join each other and form a continuous ridge on either side of the shell, the spiral cords not forming nodules as they cross the varix, two to three spiral rows of antero-posteriorly compressed nodules around the shoulder angulation, sutures with strong and oblique axial riblets. Colour yellowish brown, often ornamented with three spiral rows of dark brown spots, nodules tinged with brown, aperture white to cream with pale yellowish brown on the outer margin of the outer lip.

India : Pondicherry, rare. Indian Ocean to the Fiji Islands.

***Bursa (Bufonaria) rana* (Linnaeus, 1758)**

(Pl. 48, fig. 8, 9)

Shell large, up to 80 mm in length, spire conical and elevated, body whorl higher than broad. Aperture obliquely ovate, outer lip with about thirteen denticulations, columella without

a parietal shield but only a glazing, its basal part finely denticulate, spiral threads on the body whorl continue on to the columella, especially at the upper part; siphonal canal short. Sculptured with prominent varices, which bear spines, upper part of the body whorl with two rows of nodulose spiral cords, the one below smaller, one row on the penultimate whorl, rest of the shell surface with granulose spiral threads and spinose nodes. Colour dull white or cream, irregularly maculated with brown, aperture white or brown, often with three dark brown bands, one on the penultimate and two on the body whorl.

India : Orissa, Tamil Nadu (common), Pondicherry (not common), Andamans. Indo-Pacific.

Bursa elegans Sowerby, 1838, a much smaller species, is synonymised with this species. It however, differs in sculpture. Nodules on the shoulder are large and sharper and on the varices they are smaller. It is considered to have restricted distribution extending from Andamans to Borneo (Beu, 1986).

***Tutufa (Tutufella) rubeta* (Linnaeus, 1758)**

(Pl. 49, fig. 1)

Shell large, up to 125 mm in length, solid, heavy, fairly high spire, whorls convex and angulated. Aperture large and almost circular, outer lip flaring, with about twelve teeth on its inner edge, columella concave, with wide parietal shield, plicate throughout and plications at the base more prominent, posterior canal short, deep and open, anterior canal short, deep, almost closed and twisted. Sculptured with prominent beaded spiral cords, with two strong varices, about five strong knobs between the varices, spire whorls with prominent knobs. Colour creamy-white, irregular brown flecks and spots, aperture light yellow.

India : Andamans, offshore. Indo-West Pacific excepting Red Sea and Hawaii.

Synonyms: *Bursa lampas* of authors

Bursa bubo (Linnaeus, 1798)

***Bursa lamarckii* (Deshayes, 1853)**

(Pl. 49, fig. 3)

Shell large, up to 75 mm in length, solid, heavy, spire elevated, body whorl narrow. Aperture proportionately small, outer lip expanded and fluted with nine teeth on the outer and inner margins, columella with coarse lirations on the top and three strong plications at the base, a small callous shield, deep, extended siphonal canal curved towards the right, deep and almost closed anal canal, coarse and strong fasciole. Sculptured with two varices on each whorl, and

coarse, granular spiral ridges, with blunt knobs at the sutural region. Colour creamy white with brown markings, aperture white.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific.

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Family EPITONIIDAE

Wentle Traps

‘Wentle Trap’ is derived from a Dutch word which means winding staircase. Shell is small to medium in size, up to 40 mm in height. It is slender and highly conical or turreiform with numerous, often loosely coiled whorls. Spire is pointed with an amber brown protoconch. Aperture is circular or rounded. Some are umbilicate, while in some the umbilicus is closed by the expanded columellar margin. Sculpture consists of slightly oblique, regular, axial lamellae or varices, which are formed as the reflected outer lips at earlier pauses in the growth of the animal. Shells are white or brown, but a few may bear brown tinges or markings. Operculum is horny, thin, paucispiral to multispiral, with an almost central nucleus.

Head bears long and pointed tentacles, with eyes situated on elevations at their outer bases. Foot is short. Mantle cavity contains a ctenidium, a long bipectinate osphradium and a hypobranchial gland. Proboscis is acrembolic and bears very small lateral processes. Radula is stenoglossate. Digestive system includes two pairs of salivary glands and large stomach. There are no oesophageal glands. These are protandric hermaphrodites and do not bear a penis in the male phase. Eggs are laid in strings, and covered by sand grains.

Wentle Traps are cosmopolitan, occurring from shallow intertidal region to great depths. These feed on cnidarians especially sea anemones, soft corals *etc.* Many of them are parasitic. There are numerous genera (over 50) and estimated 250 species.

Taxonomy of Indian Epitoniidae is very confusing. A number of species have been mentioned in literature without proper descriptions. As is the case with the families of several Indian molluscs there is no revisionary work. Identification of species has been done on the basis of the National Zoological Collections in the Zoological Survey of India, which however is not updated. The number and form of varices, shape of the base, amount of spiral ribbing are taken into account. Kilburn (1985) mentioned the problems in the identification of epitoniids, and considered the nature of protoconch and presence of pitted interitacalx as the two major reliable characters.

***Amaea (Acrilla) acuminata* (Sowerby, 1844)**

(Pl. 49, fig. 4)

Shell of medium size, up to 32 mm in length, narrow, glossy, elongately turreted, acuminate, whorls 15, convex with impressed sutures, aperture elongately oval, columella thin, arched, flattened inwardly, outer lip thin and fragile, umbilicus absent. Sculptured with very close-set transpiral ribs, a fine presutural spiral rib, body whorl with a keel at the base. Colour cream with two brown spiral bands.

India : Maharashtra : Bombay; Tamil Nadu : Madras, Point Calimere, Agasthiampalli, Tranquebar; Pondicherry: Karaikal; Orissa : Chandipur. Indo-Pacific.

Amaea (Acrilla) gracilis (Sowerby, 1844)

(Pl. 50, fig. 9–11)

Shell small, up to 10 mm in height, whorls eight, rounded with attenuated spire, aperture ovate, acuminate at the base, outer lip thin, columella curved, imperforate. Sculptured with thread-like axial ribs enclosing glossy interstices, and fine spiral striae, body whorl without a keel.

India : Maharashtra: Bombay; Orissa: Chandipur (common); West Bengal: Sunderbans, Sandheads, Digha, common. Elsewhere: Philippines.

Eglisia tricarinata Adams and Reeve

(Pl. 50, fig. 5)

Shell small, up to 20 mm in height; numerous rather inflated whorls, aperture small and round, with a thick columella. Sculptured with two to three smooth spiral ribs on each whorl, the interstices cancellately and finely sculptured.

India : Orissa, Tamil Nadu.

Epitonium immaculatum (Sowerby, 1844)

(Pl. 49, fig. 7)

Shell small, up to 18 mm in length, elongate, whorls contiguous, tumid and rounded with deep and crenulated sutures. Aperture ovate, peristome thickened, subumbilicate. Sculptured with thin, unequal, irregular axial varices, indistinct spiral striae, white.

India : Maharashtra: Bombay; Tamil Nadu: Gulf of Mannar (Tuticorin, Mandapam); Orissa, not very common. Elsewhere: Philippines.

Epitonium (Papyriscala) latifasciatum (Sowerby, 1874)

(Pl. 50, fig. 3)

Shell small, up to 13 mm in length, pyramidal, whorls round, increasing rapidly, suture deeply impressed, aperture oval, outer lip uniformly but weakly thickened, narrowly umbilicate. Sculptured with numerous thin, plate-like transpiral varices. Colour reddish-yellow or white.

India : Maharashtra : Bombay; Tamil Nadu : Gulf of Mannar (Tuticorin), Agasthiampalli. Indian Ocean.

***Epitonium (Epitonium) pallasi* (Kiener, 1838)**

(Pl. fig.)

Shell small, up to 20 mm in length, pyramidal, whorls 7-8, a little disunited often joined only by the lamellae, aperture ovate, outer lip laminate and reflected, umbilicus deep. Sculptured with about ten prominent, widely spaced lamellae on each whorl, and slightly angular near sutures. Colour orange brown, with apex shiny pale orange-brown, lamellae and aperture white, interior pale orange-brown.

India : Tamil Nadu: Madras, Agasthiampalli, rare. Indo-Pacific.

***Epitonium pyramidale* (Sowerby, 1844)**

(Pl. 50, fig. 2)

Shell small, up to 20 mm in length, pyramidal, with nine subventricose whorls scarcely in contact, aperture subcircular, outer lip laminate, columella touching crests of all varices and produced anteriorly into small beak. Sculptured with laminated varices, angulated at top near the suture, transpirally connected at suture and continued obliquely on spire, varices on body whorl converging below covering umbilicus. Colour white.

India : Tami Nadu : Madras, Agasthiampalli, Gulf of Mannar (Mandapam). Indian Ocean and West Pacific Ocean.

***Epitonium scalare* (Linnaeus, 1758)**

(Pl. 50, fig. 4)

Precious Wentle Trap. Shell largest in the genus, up to 50 mm in length, whorls seven, sutures deep, body whorl almost as broad as high, aperture round, with thickened lips, umbilicus very deep, sculptured with eight lamellae per whorl, lamellae join the whorls. Colour pale flesh, lamellae and lips white, aperture interior pale flesh.

India : Pondicherry. Indo-Pacific.

***Epitonium subauriculatum* (Souverbie, 1866)**

(Pl. 50, fig. 6a-e, 7)

Shell small, up to 11 mm in height and 5 mm width, narrow, alternate with rounded whorls. Aperture round, umbilicus absent, with lamellate peristome. Sculptured with prominent, moderately thick and subreflexed varices, varices seven, widely separated and extend into spire. Colour white.

India : Tamil Nadu : Tuticorin. Indo-West Pacific.

***Gyroscala lamellosua* (Lamarck, 1822)**

(Pl. 49, fig. 5, 6)

Shell small, up to 18 mm in length, pyramidal, with eight round and contiguous whorls. Aperture obliquely ovate, outer lip thickened and slightly reflected, umbilicus absent. Sculptured with laminated and broad varices connected at suture, continued on to spire, body whorl with twelve lamellae and a spiral rib separating the upper and lower half. Colour pale fawn, dark to light brown between varices; apex, aperture and varices white.

India : Tamil Nadu : Gulf of Mannar (Tuticorin, Mandapam); Pondicherry, not common. Indo-Pacific.

***Cirsotrema (Cirsotrema) varicosum* (Lamarck, 1822)**

(Pl. 50, fig. 1)

Shell small, up to 42 mm in height, acuminate, with a developed basal cord, whorls 8, sculptured with axial and spiral ribs, peristome continuous and thickened.

India : Andamans. Indo-Pacific.

Synonym : *Scalaria varicosa* Lamarck, 1822.

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- Dushane, H. 1979. The family Epitoniidae in the Northeastern Pacific. *Veliger*, **22**(2) : 91-134.
Kilburn, R. N. 1985. Epitoniidae in South Africa. *Ann. Natal Mus.*, **27**(1) : 239-337.

Family JANTHINIDAE

Violet Snails

Shell usually is small, up to 25 mm in length. It is thin and fragile with a few whorls and depressed or elevated spire. Aperture is ovate, sometimes becomes angular by the presence of carina or extended columella. Outer lip margin is sharp. It does not have an umbilicus. Surface usually is smooth but often may have spiral or axial striae. It is violet, white or brownish coloured. There is no operculum

Head is large with bifid tentacles. Eyes are reduced or absent. Foot is broad and short. It is divided into an anterior propodium and a posterior mesopodium. The former captures air bubbles that are entangled in a transparent secretion of mucus to form a float. This long, tongue-shaped, frothy float is attached to the mesopodium. The float helps the animal to keep afloat on the surface of sea.

Mantle cavity contains the ctenidium, osphradium and a hypobranchial gland that releases violet secretion. Alimentary system consists of a ptenoglossate radula without a central tooth, oesophagus without glands and a large stomach.

Violet Snails are protandric hermaphrodites in which male phase has no penis. These are either oviparous or ovoviviparous. Egg capsules are attached in bundles to the underside of the float. Veliger larva has an operculum.

Violet Snails are pelagic, occurring worldwide in high seas. They feed on siphonophores especially *Velella*, *Porpita* and *Physalia*. Dead shells in large numbers may sometimes get washed ashore after stormy weather. It is a small family consisting of two genera and about thirty species.

Janthina janthina (Linnaeus, 1758)

(Pl. 51, fig. 1–3)

Shell small, up to 25 mm in height, thin and fragile, whorls four, and convex with low spire, sutures well marked, body whorl markedly angular centrally. Aperture large and somewhat squarish, columella and outer lip thin, base of columella rather angulated. Surface of the shell sculptured with minute growth striae and a few spiral grooves, which become markedly stronger on the flattened base of the body whorl. Colour pale violet above the angular part of the body whorl and deep violet below.

India : Gujarat, Maharashtra, Tamil Nadu, Andhra Pradesh, common. Cosmopolitan.

Synonyms : *Janthina communis* Lamarck, 1822

Janthina fragilis Lamarck, 1822

Janthina roseola Reeve, 1858

Janthina violacea Roeding, 1798

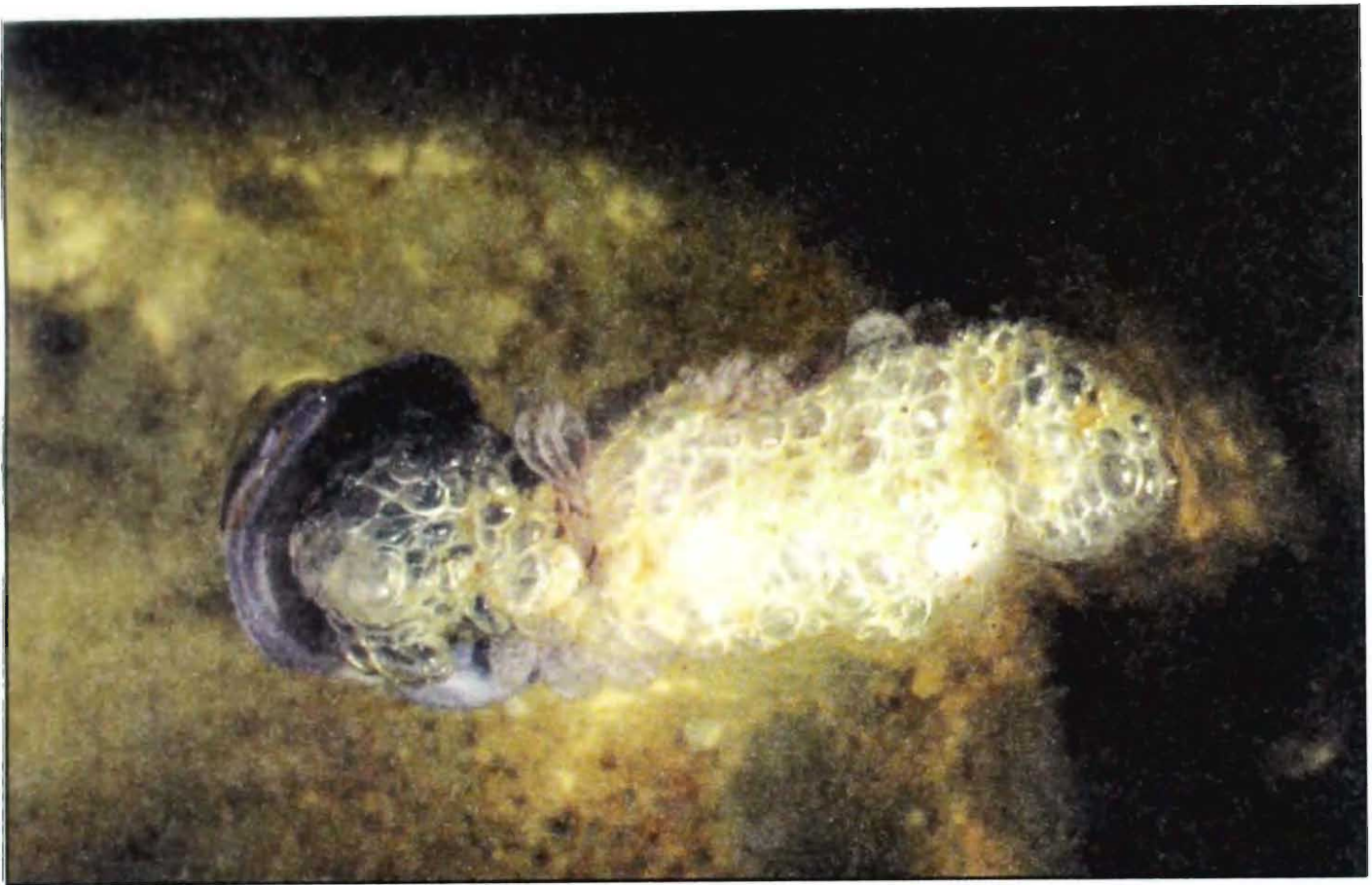


Fig. 31. *Janthina globosa*.

Janthina globosa Swainson, 1822

(Pl. 51, fig. 5, 6)

Shell generally smaller than in the preceding species, maximum up to 23 mm in height, thin and fragile, easily distinguished from *J. janthina* by its more globose, evenly rounded body whorl that lacks the angled periphery of the former. Aperture large and drawn out anteriorly, columella drawn out anteriorly. Sculpture as in *J. janthina*. Colour violet throughout, with pale subsutural area or white band at the sutures. Outer lip broken in all the shells.

India : Occurs along with *Janthina janthina*, but not so common. Cosmopolitan.

Recluzia jehennei Petit, 1853

(Pl. 51, fig. 4)

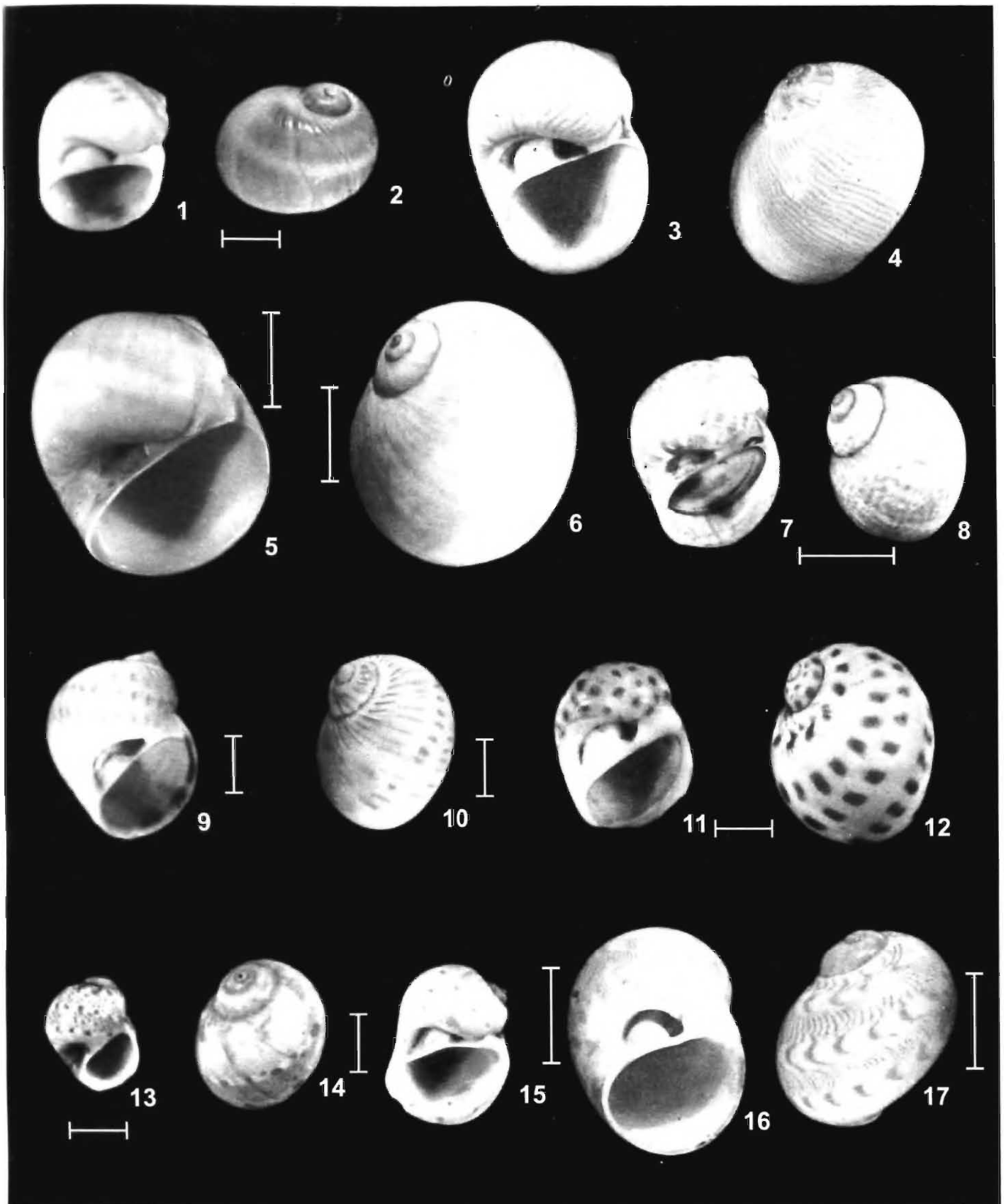
Shell small, up to 18 mm in height, thin and fragile, glossy, whorls six and rounded, spire highly elevated, sutures deep. Aperture almost circular, columella slightly twisted, umbilicus rather obsolete. Surface with indistinct irregular growth striae. Colour cream.

India : Nicobars. Elsewhere : Gulf of Arabia.

Selected Bibliography

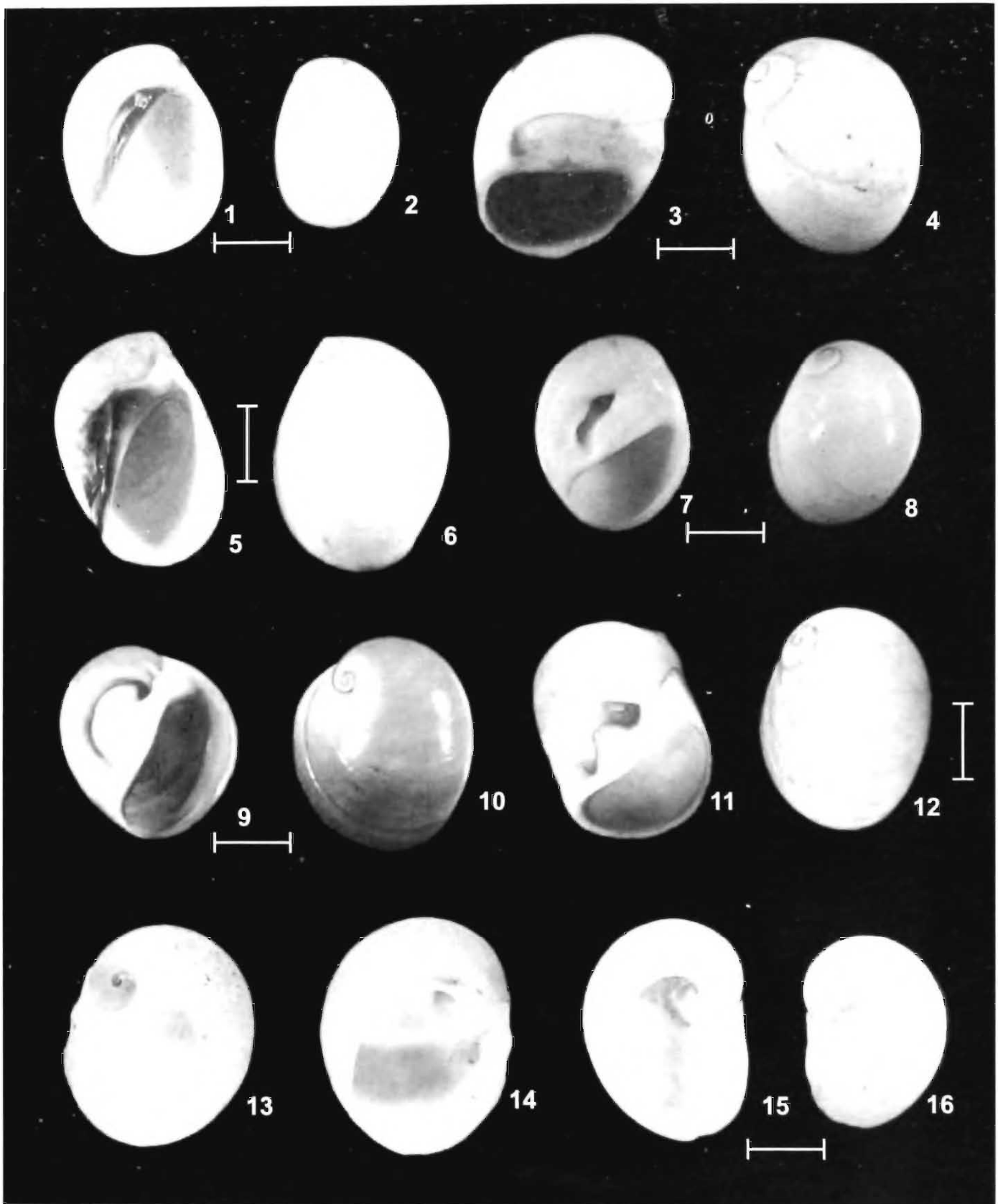
- Ganapati, P. N. and Subba Rao, D. V. 1959. Notes on the feeding habits of *Janthina janthina* Linn. *J. mar. biol. Ass. India*, **1**(2) : 251-252.
- Laursen, D. 1953. The genus *Ianthina*. *Dana Report* No. **38** : 1-40
- Risbec, J. 1953. Note sur la biologie et l'anatomie de *Janthina globosa*. *Bull. Soc. Zool. France*, **78**(2-3) : 194 – 201.

Plate 37 : Naticidae



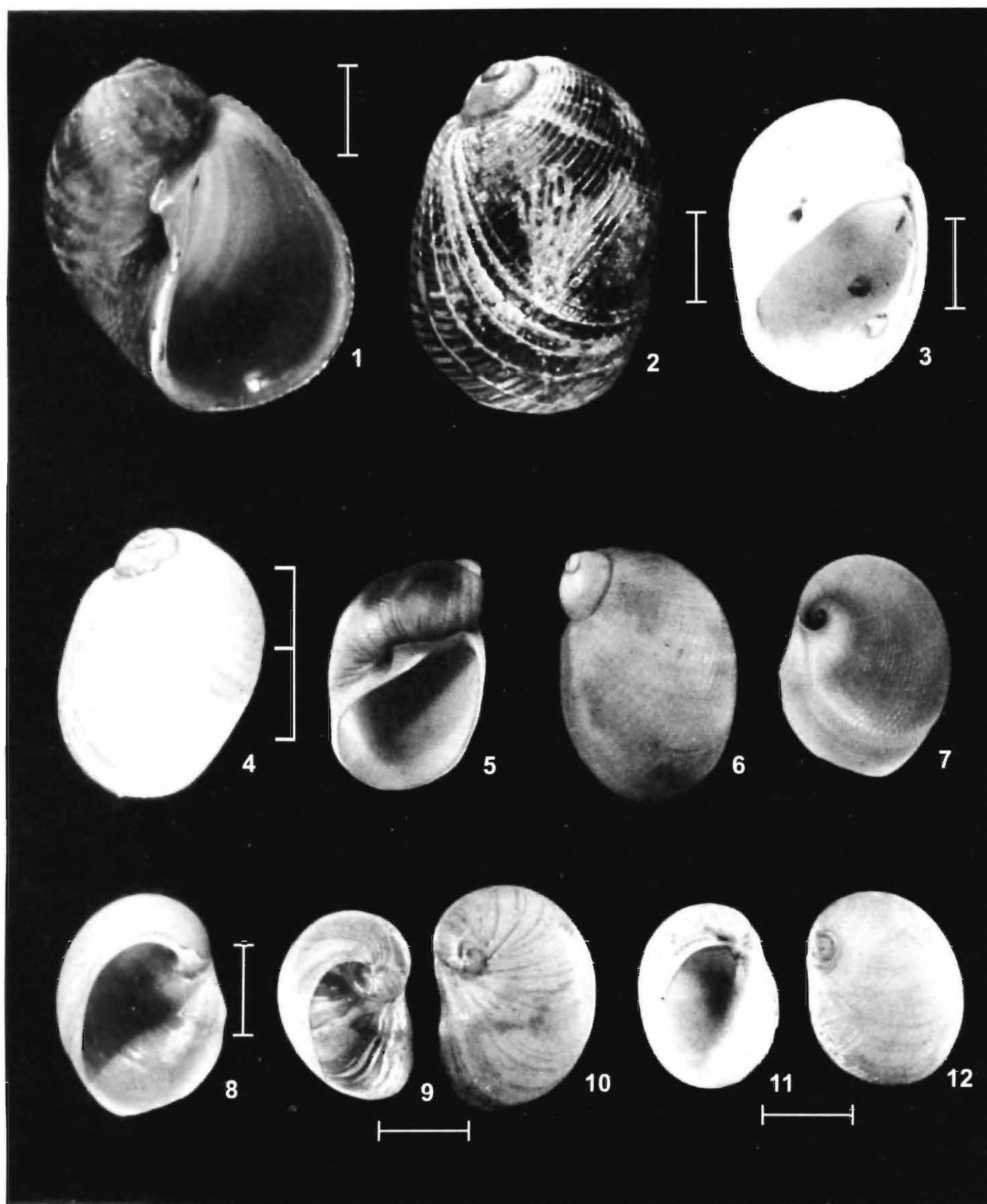
1,2. *Natica gualteriana* ; 3,4. *Natica lineata*; 5,6. *Natica vitellus*; 7,8. *Natica tigrina* : 1537, India; 9,10. *Naticarius manceli* : 1540, India; 11,12. *Naticarius onca* : 1544, Andamans; 13,14. *Natica pulicaria*; 15. *Naticarius alapapiliones*; 16,17. *Tanea euzona*.

Plate 38 : Naticidae



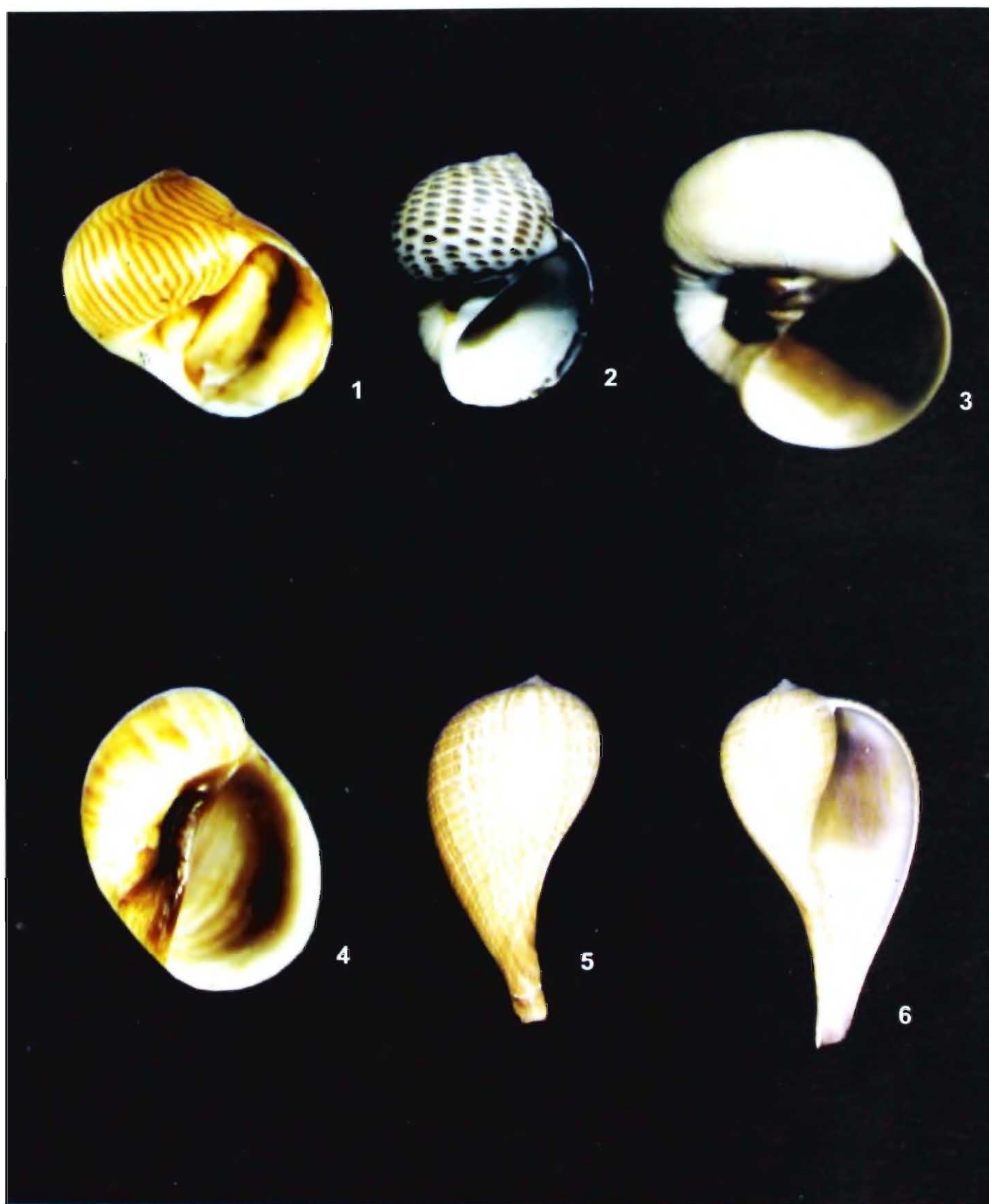
1, 2. *Polinices sebae*; 3, 4. *Polinices (Polinices) mammilla* : Andamans; 5, 6. *Polinices (Mammilla) melanostoma*; 7, 8. *Polinices (Polinices) flemingiana*; 9, 10. *Neverita alba*; 11, 12. *Neverita pesselephanti*; 13, 14. *Sinum neritoideum* : Madras, Tamil Nadu, 10mm; 15, 16. *Sinum haliotoideum*.

Plate 39 : Naticidae



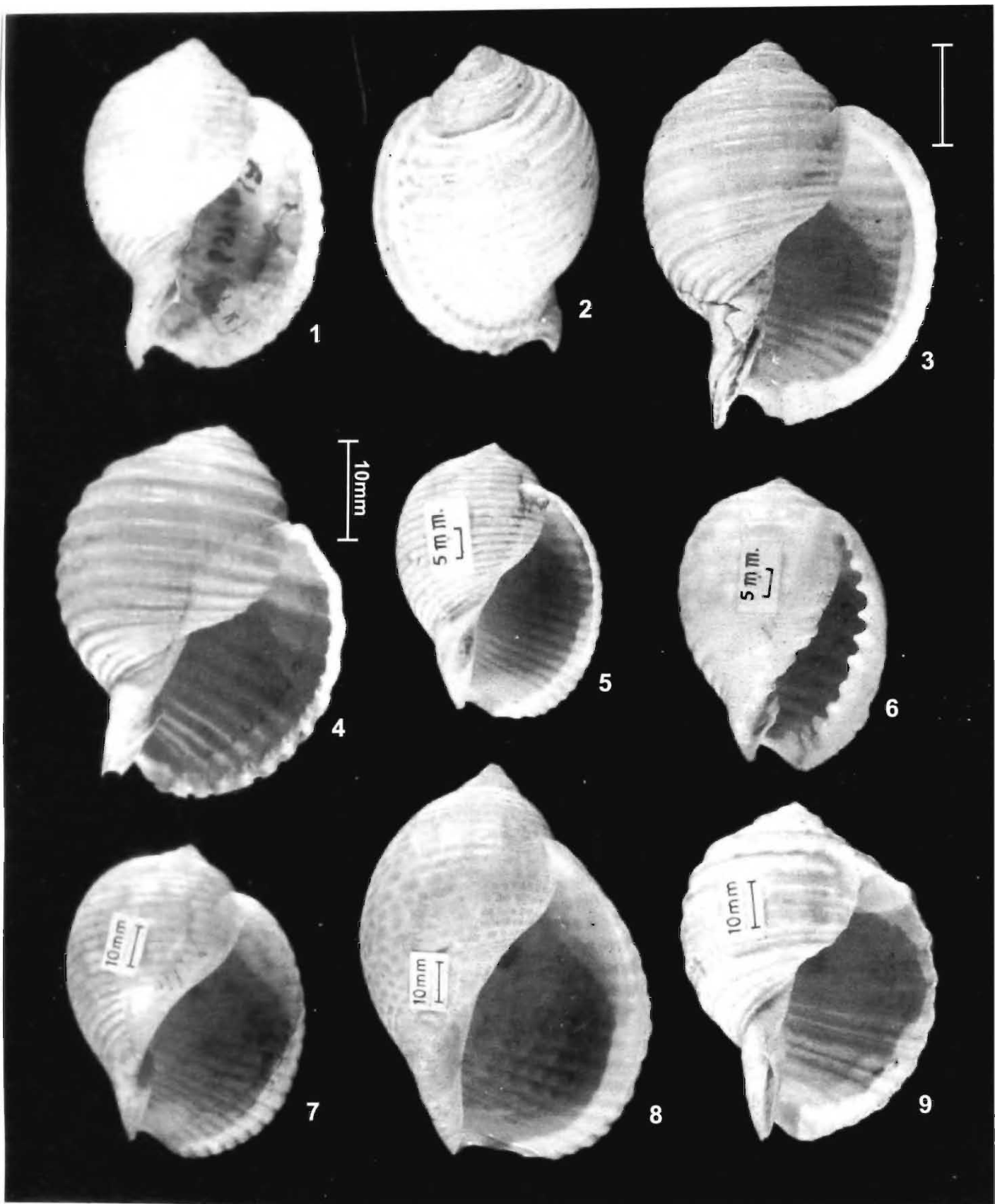
1, 2. *Eunaticina (Eunaticina) linneana*; 3, 4. *Eunaticina (Eunaticina) coarctata*; 5, 6. *Eunaticina (Eunaticina) papilla*; 7, 8. *Sinum delesserti*; 9, 10. *Sinum haliotoideum*; 11, 12. *Sinum laevigatum*.

Plate 40 : Naticidae



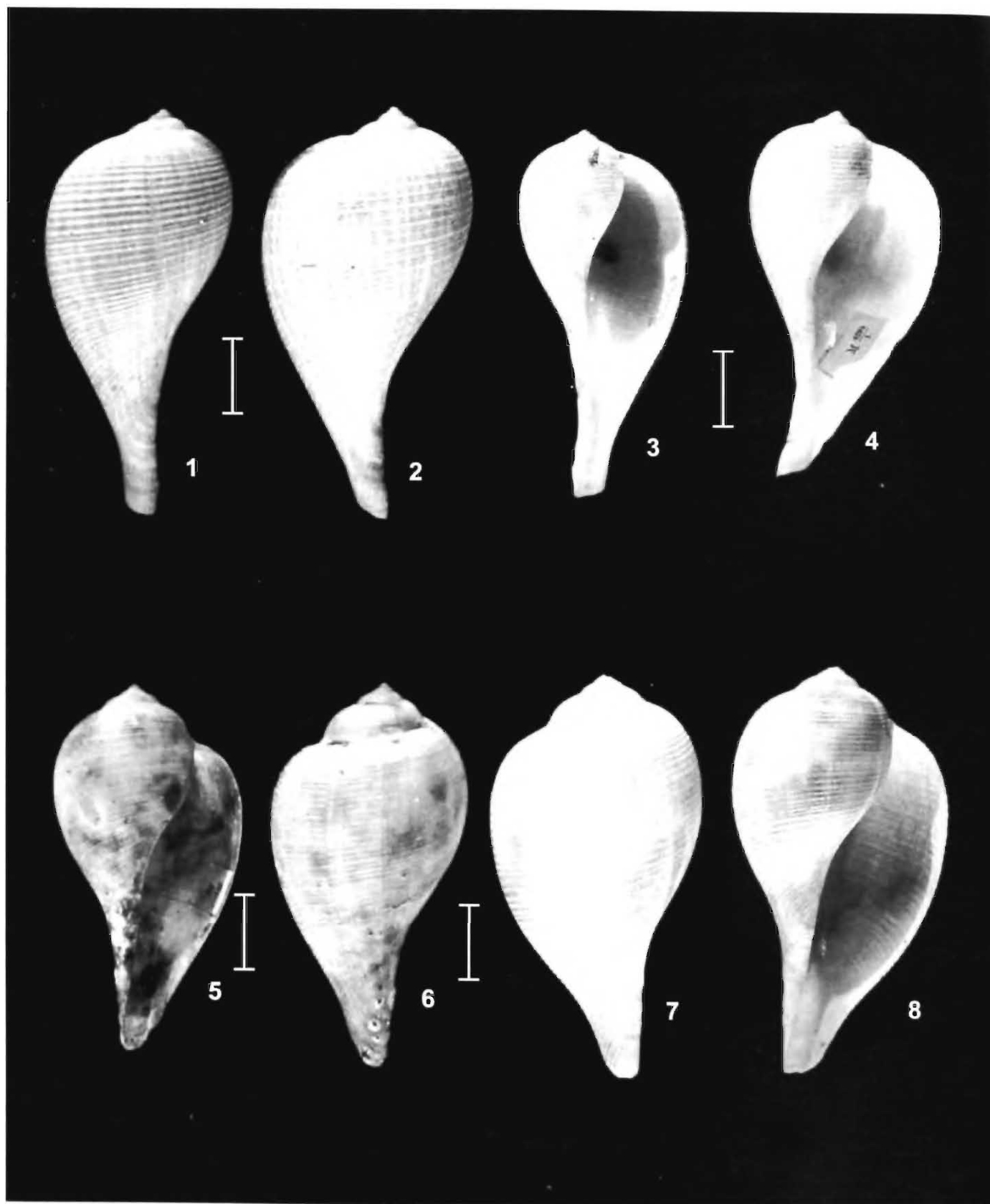
1. *Natica lineata*; 2. *Natica tigrina*; 3. *Natica didyma*; 4. *Polinices melanostomus*; 5,6. *Ficus gracilis*.

Plate 41 : Tonnidae



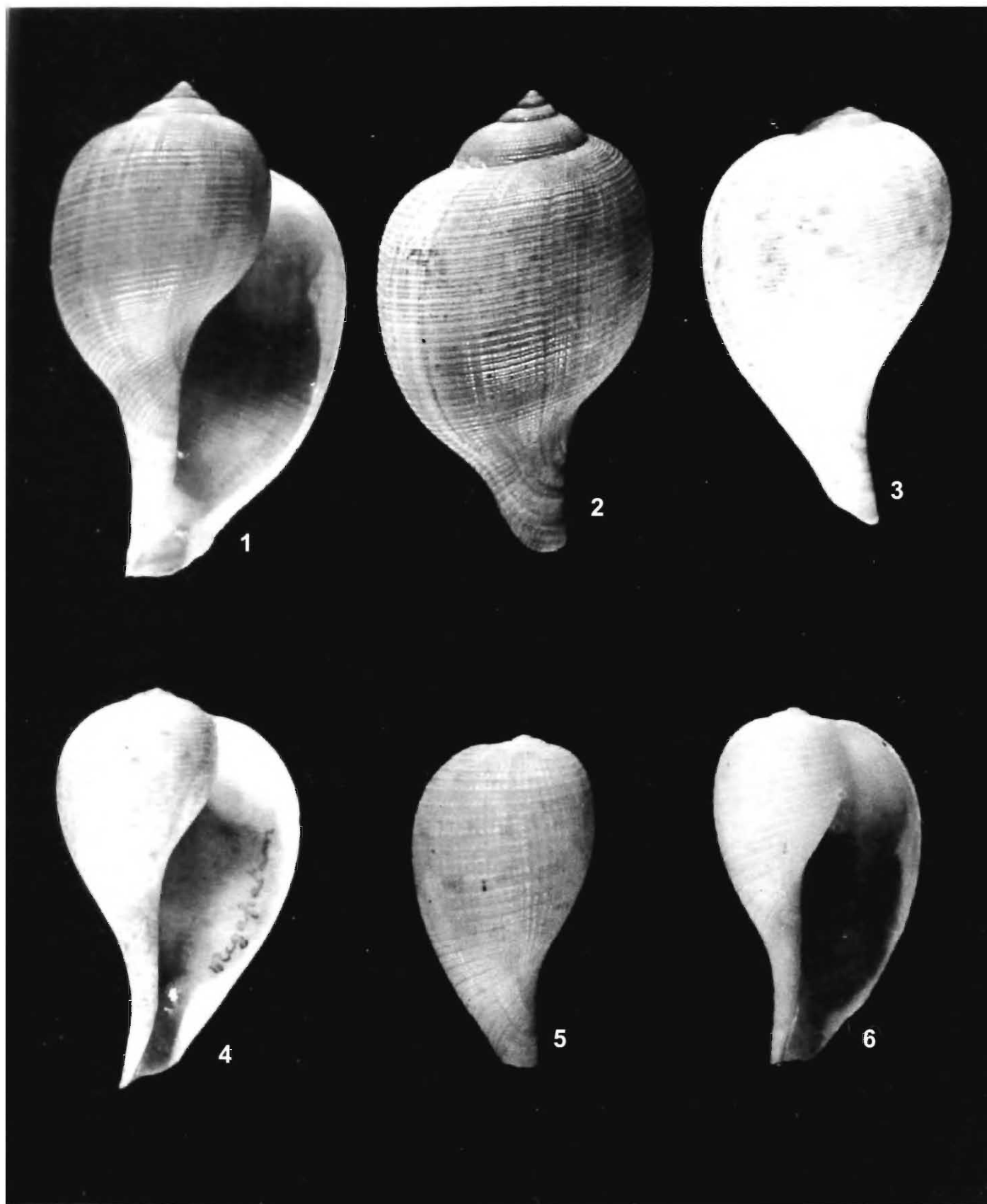
1,2. *Dolium varicosum* : Holotype, M 4411/1, Balasore Bay, Orissa; 3. *Tonna sulcosa* : off Pondicherry; 4. *Tonna tessellata* : Andamans; 5. *Tonna cumingii* : 22589/4, off Tuticorin; 6. *Malea pomum* : Indian Seas; 7. *Tonna cepa* : Indian Seas; 8. *Tonna perdix* : Nan Cowry harbour, Nicobar; 9. *Tonna dolium* : Pondicherry.

Plate 42 : Ficidae



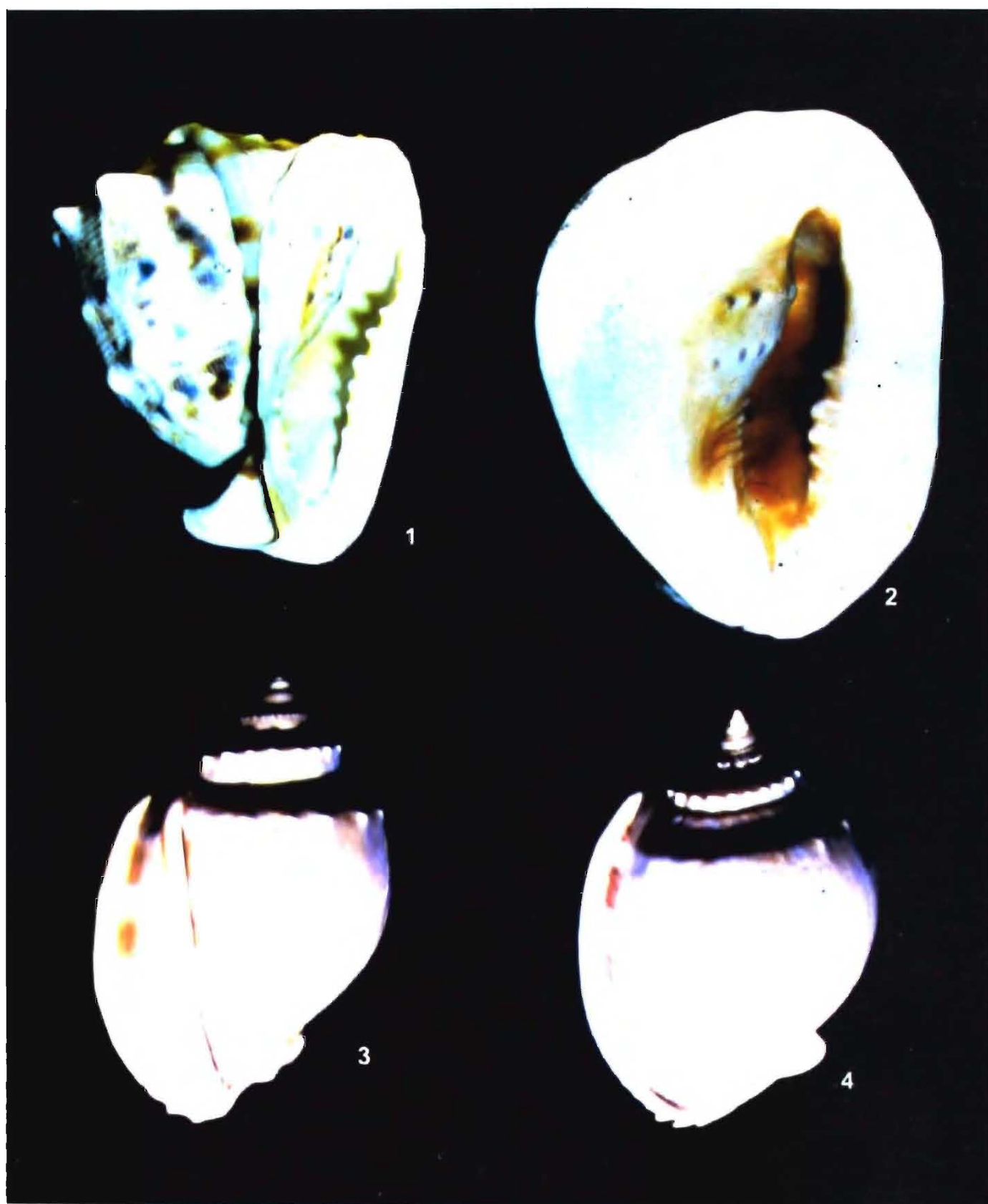
1-4. *Ficus gracilis* : M 2591, Bhimilipatnam, Andhra Pradesh; 5, 6. *Ficus variegata* : Nagapattanam, Tamil Nadu; 7, 8. *Pirula sewelli* : Holotype, M 12573/2, 80.9x43.03.

Plate 43 : Ficidae



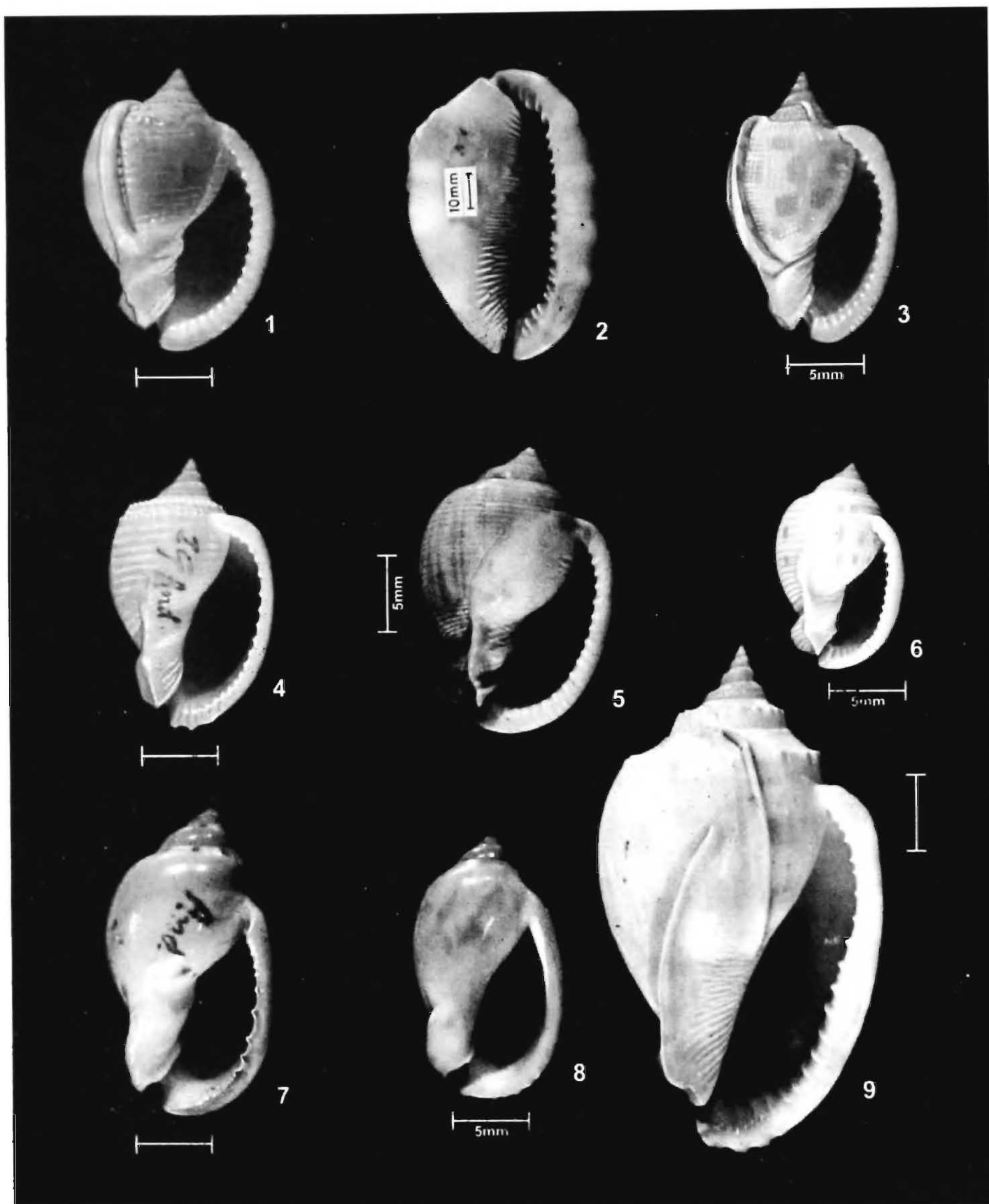
1,2. *Ficus investigatoris*-Holotype : M 281/ 1, 80.9x47.6; 3,4. *Ficus investigatoris* : M 768-770/1, Sta. 258, Marine Survey; 5,6. *Ficus ficoides* : Point Calimere, Tamil Nadu.

Plate 44 : Cassidae



1,2. *Cassis cornuta* : Andamans; 3,4. *Phalium glauca*.

Plate 45 : Cassidae



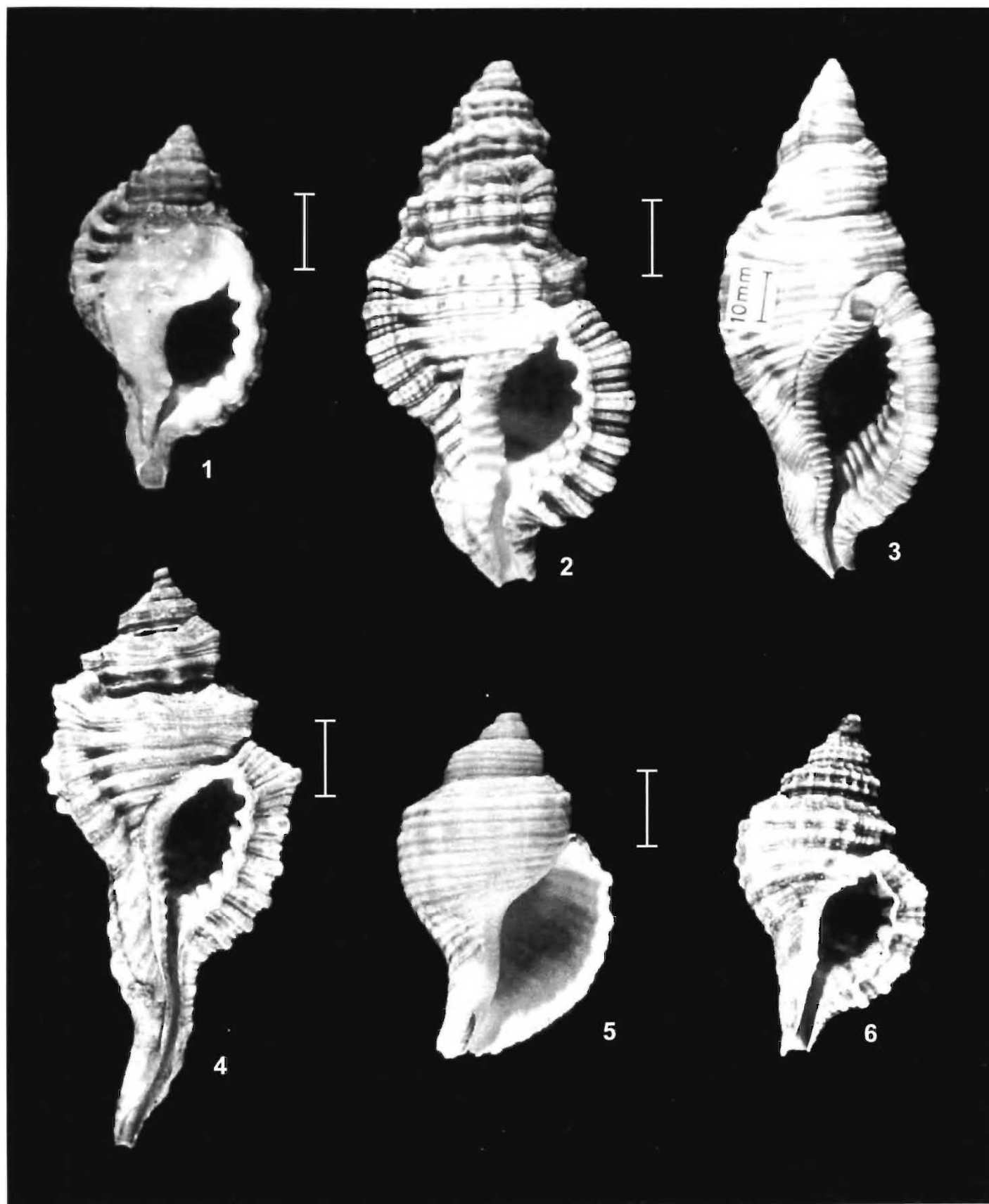
1,3. *Phalium areola*: Visakhapatnam; 2. *Cypraecassis rufa* : Andamans; 4. *Phalium glaucum* :
 5. *Phalium bisulcatum bisulcatum* : M 22662/4, Veerapandianpattinam, Tamil Nadu; 6. *Casmaria*
ponderosa ponderosa : Andamans; 7. *Phalium faurotis*; 8. *Casmaria erinaceus erinaceus*;
 9. *Phalium bandatum bandatum* : 2576, Indian Seas.

Plate 46 : Ranellidae



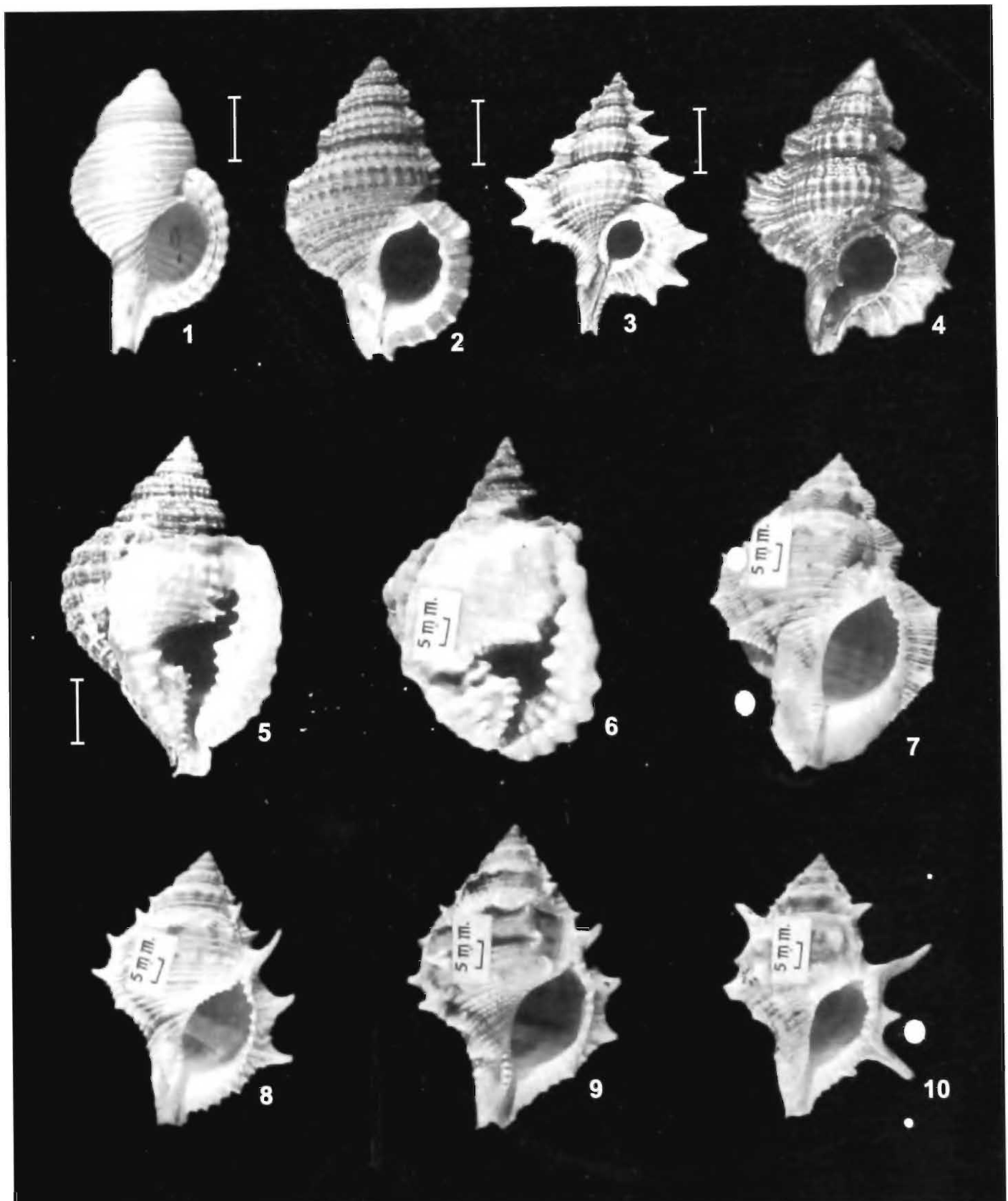
1. *Cymatium tripus*; 2. *Bursa echinata*; 3,4. *Distorsio reticularis*; 5,6. *Charonia tritonis*.

Plate 47 : Ranellidae



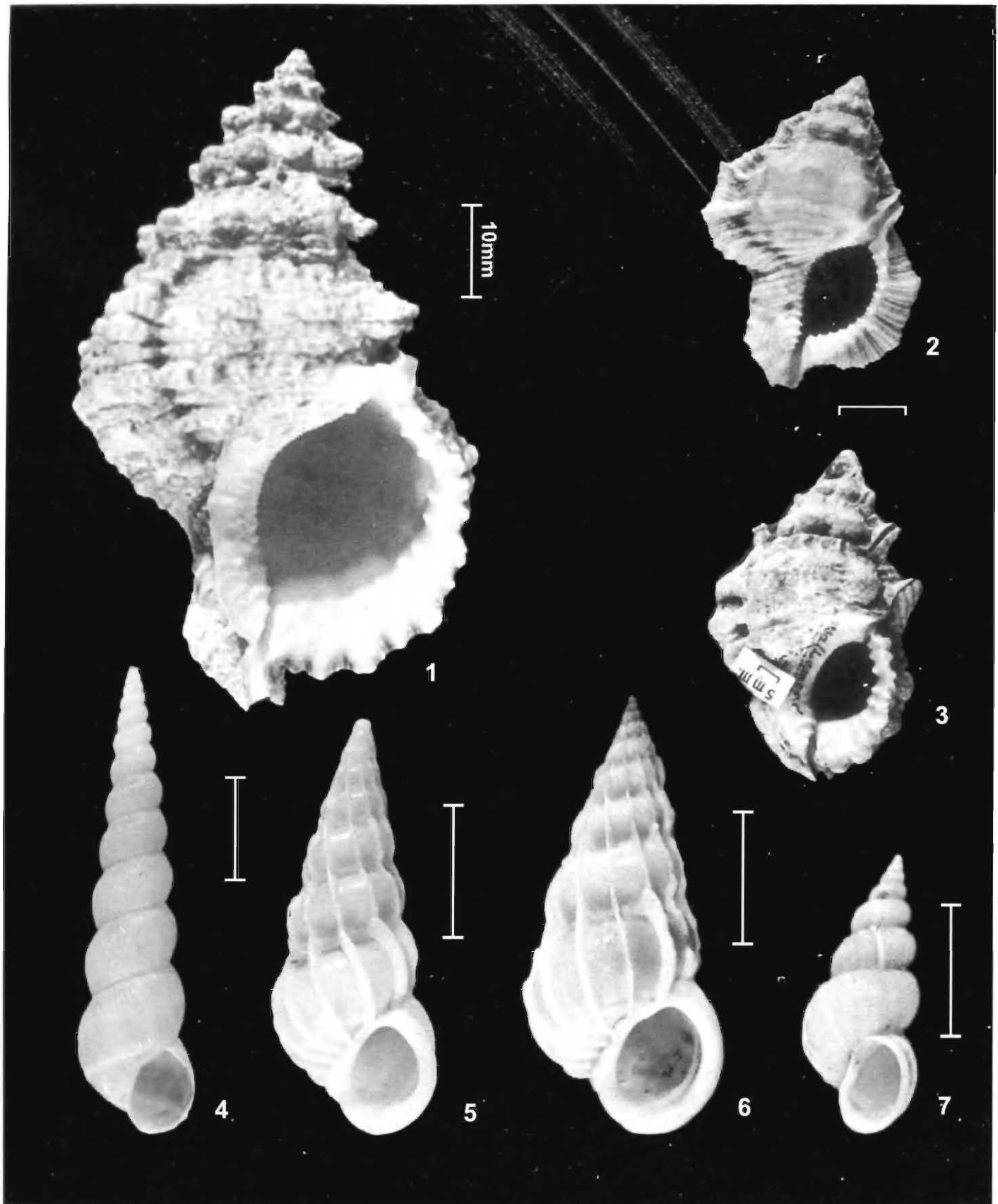
1. *Cymatium muricinum*; 2. *Cymatium nicobaricum* : 2655, Indian Seas; 3. *Cymatium pileare*; 4. *Cymatium vespaceum*; 5. *Cymatium (Linatella) cutacea*; 6. *Cymatium (Monoplex) penneketi*.

Plate 48 : Ranellidae



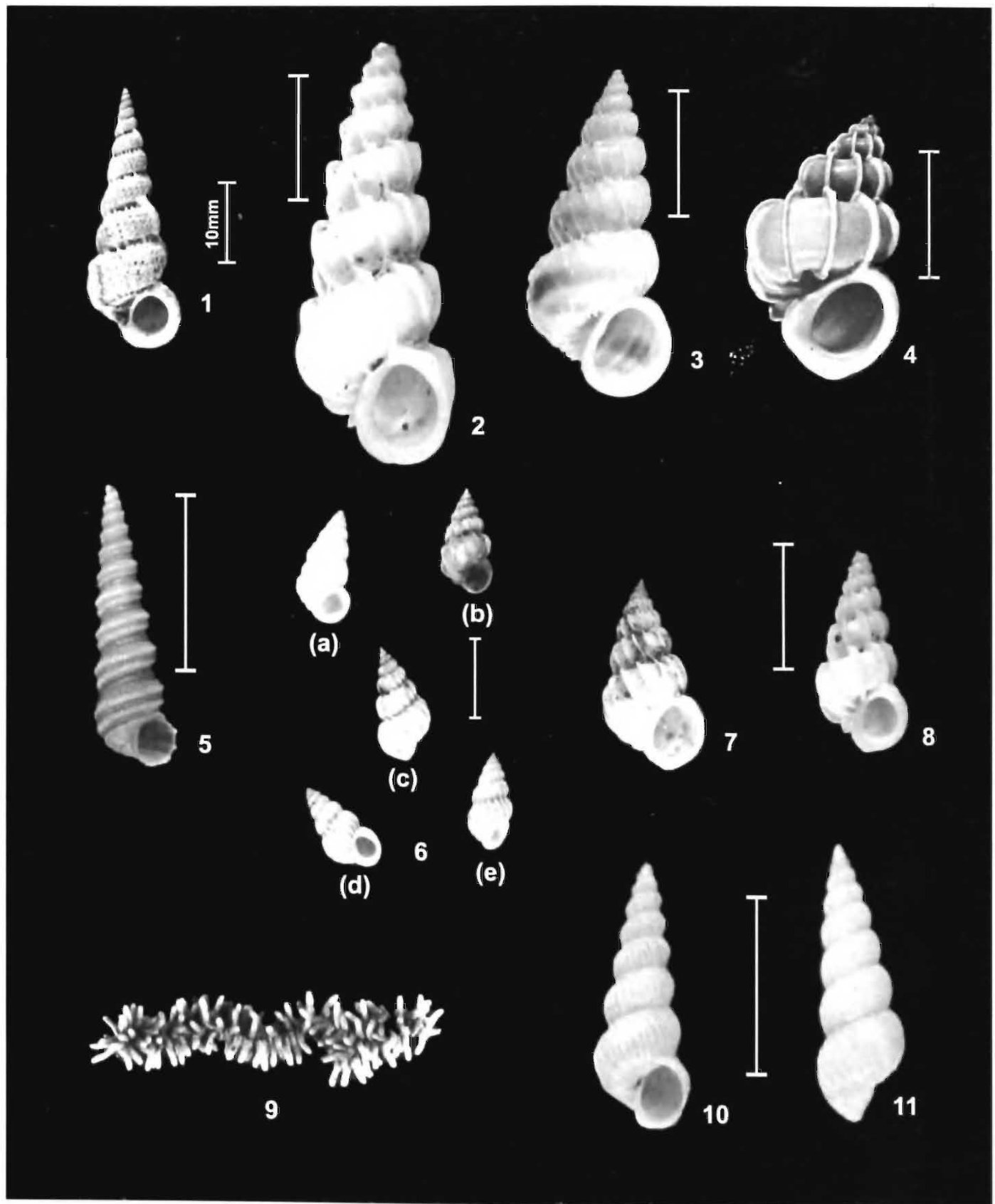
1. *Cymatium (Gelagna) succinctum* : 5mm; 2. *Gyrineum natator* : 5mm; 3. *Biplex pulchra* : Sta. 151, Marine Survey; 4. *Biplex bozzetti* : Sta. 226, Andamans, Marine Survey. 10 mm; 5. *Distorsio reticularis* : Sta.216, Marine Survey, 10mm; 6. *Distorsio anus* : 2714, Andamans, 5mm; 7. *Bursa crumena crumena* : 2602, Indian Seas, 5mm; 8,9. *Bursa rana* 5mm; 10. *Bursa echinata* : 22679/4, near Madras.

Plate 49 : Bursidae, Epitoniidae



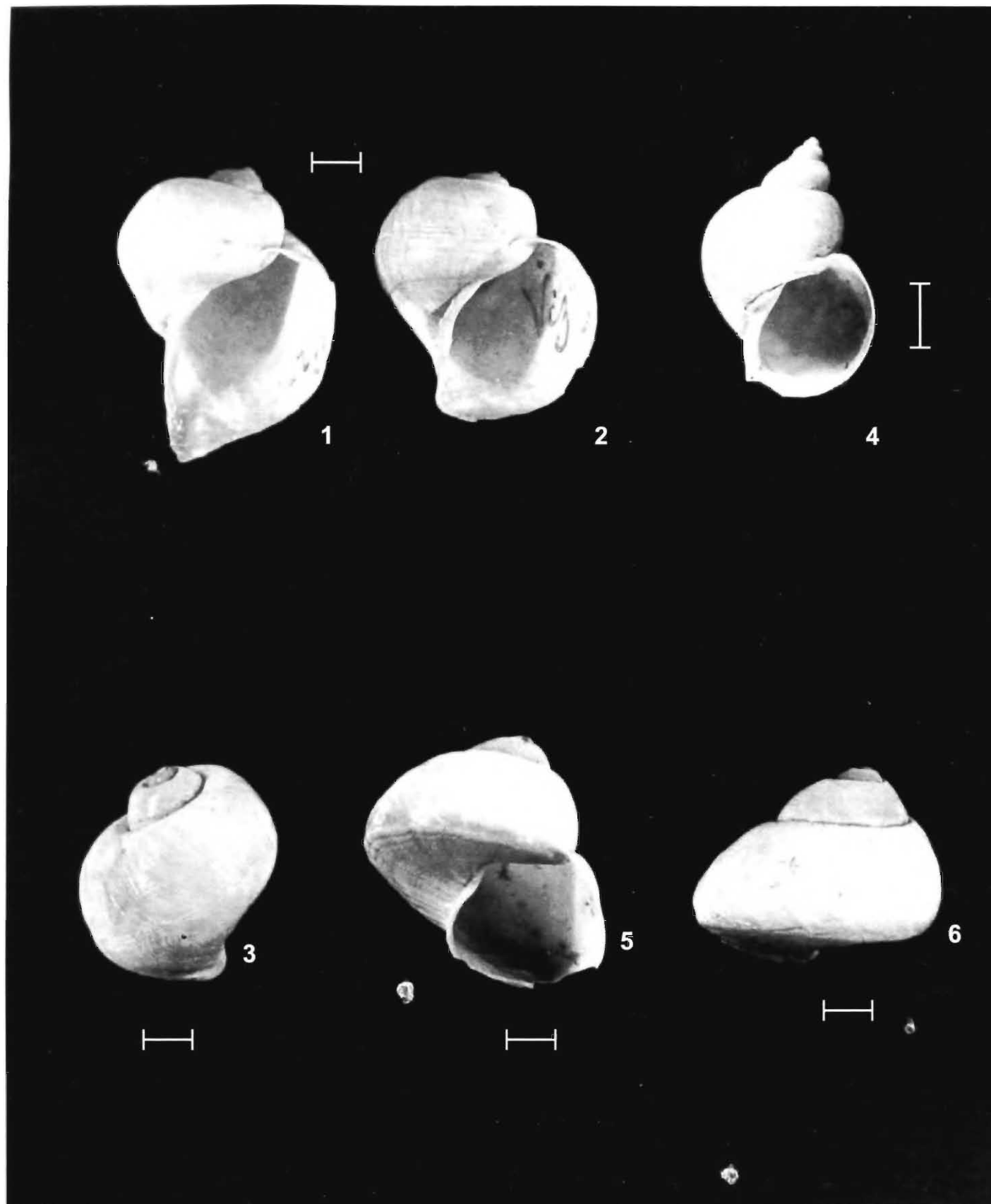
1. *Tutufa (Tutufella) rubeta*; 2. *Bursa (Bufonaria) margaritula*; 3. *Bursa lamarckii*; 4. *Amaea (Acrilla) acuminata*; 5,6. *Gyroscala lamellosa*; 7. *Epitonium immaculatum* : Andamans.

Plate 50 : Epitoniidae



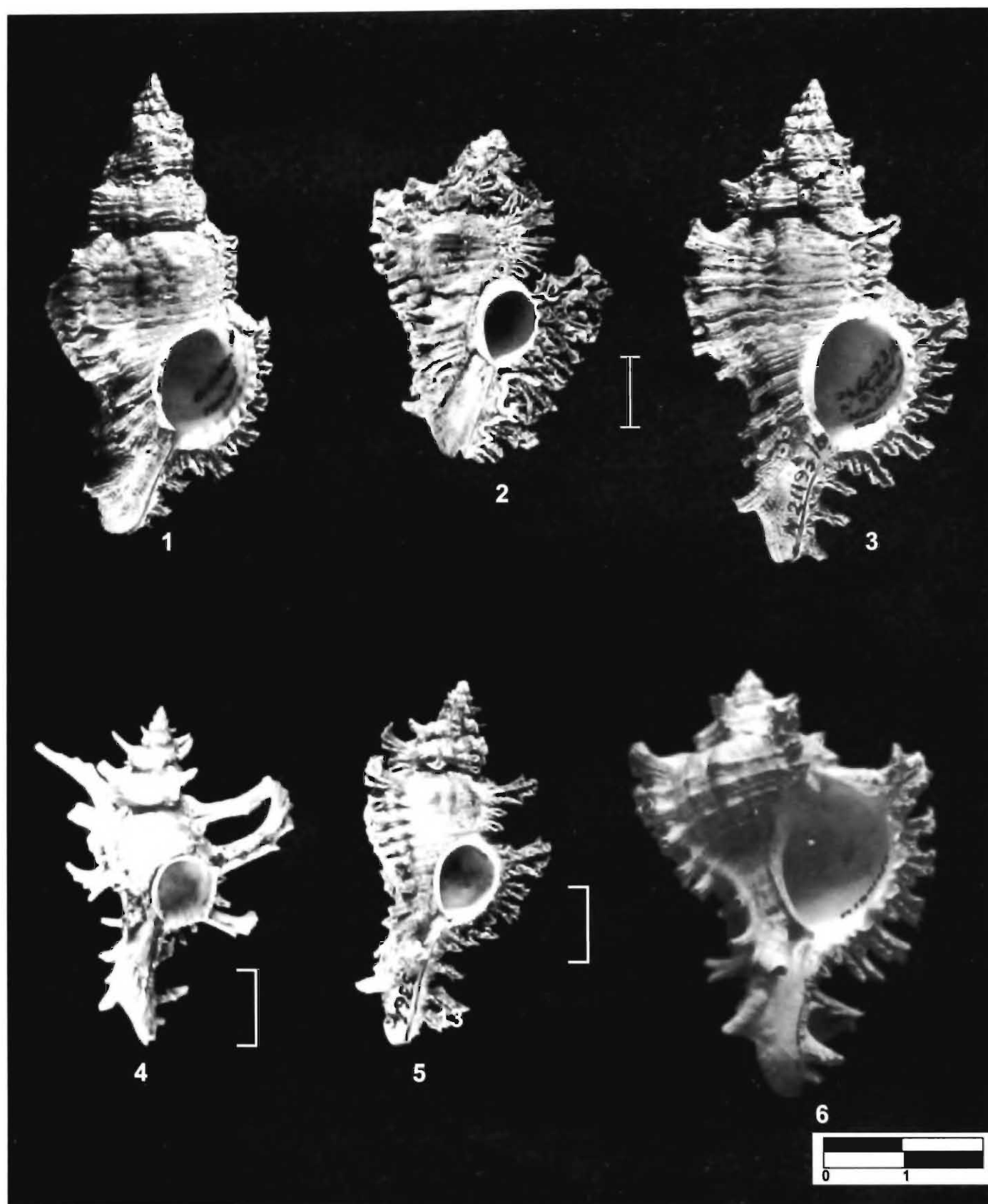
1. *Cirsotrema (Cirsotrema) varicosum* : 954, Andamans; 2. *Epitonium pyramidale*; 3. *Epitonium latifasciatum* : Agasthyampalli, Tamil Nadu; 4. *Scalaria pallasi* ; 5. *Eglisia tricarinata*; 6. a-e; 7. *Epitonium subauriculatum*; Tuticorin. 8. *Epitoneum (Parviscala) multicostata* : Andamans; 9. Egg case of *Acrilla gracilis*; 10,11. *Acrilla gracilis* : *Epitoneum scalare*.

Plate 51 : Janthinidae



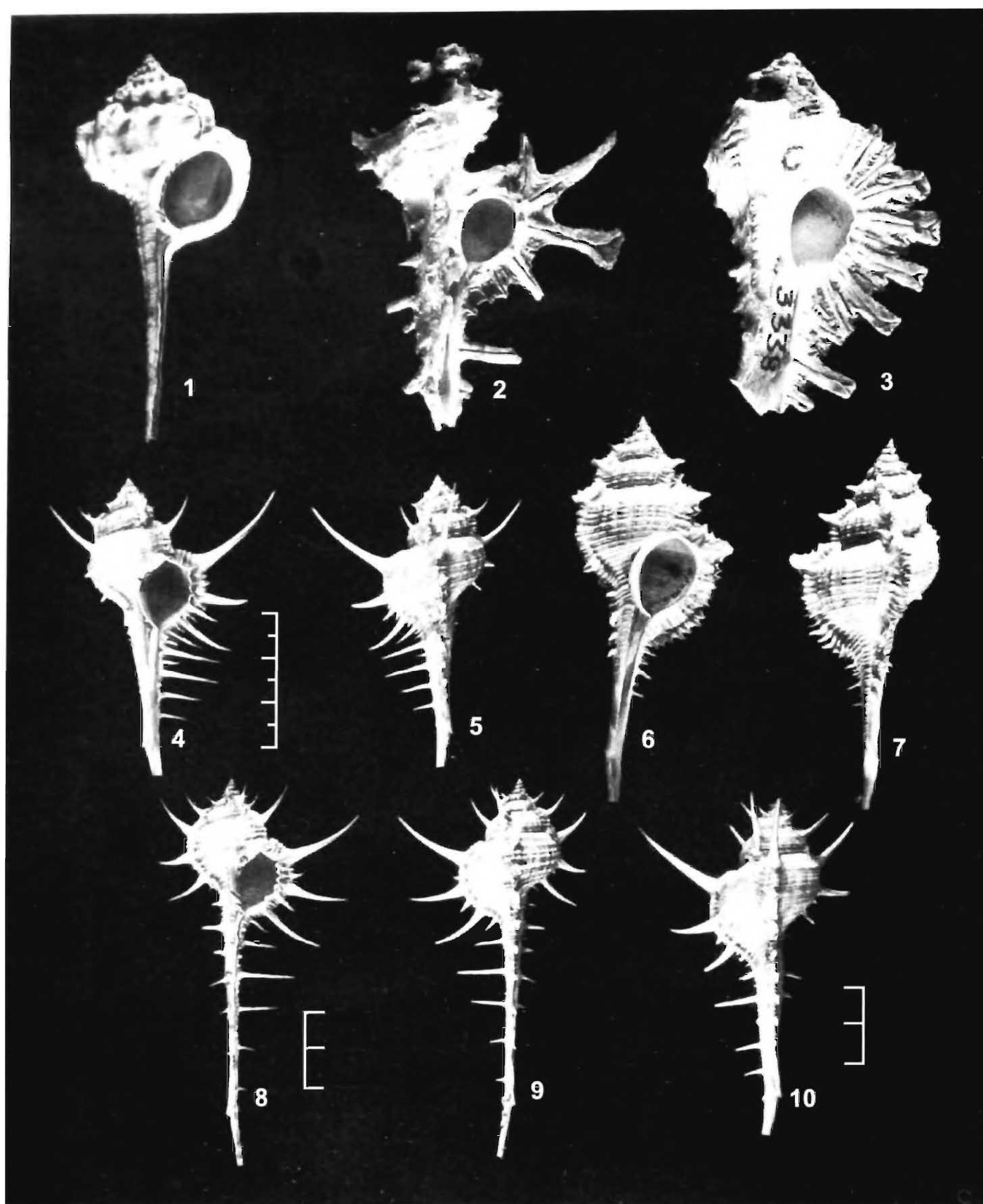
1-3. *Janthina janthina*; 4. *Recluzia jehennei*; 5,6. *Janthina globsa*.

Plate 52 : Muricidae



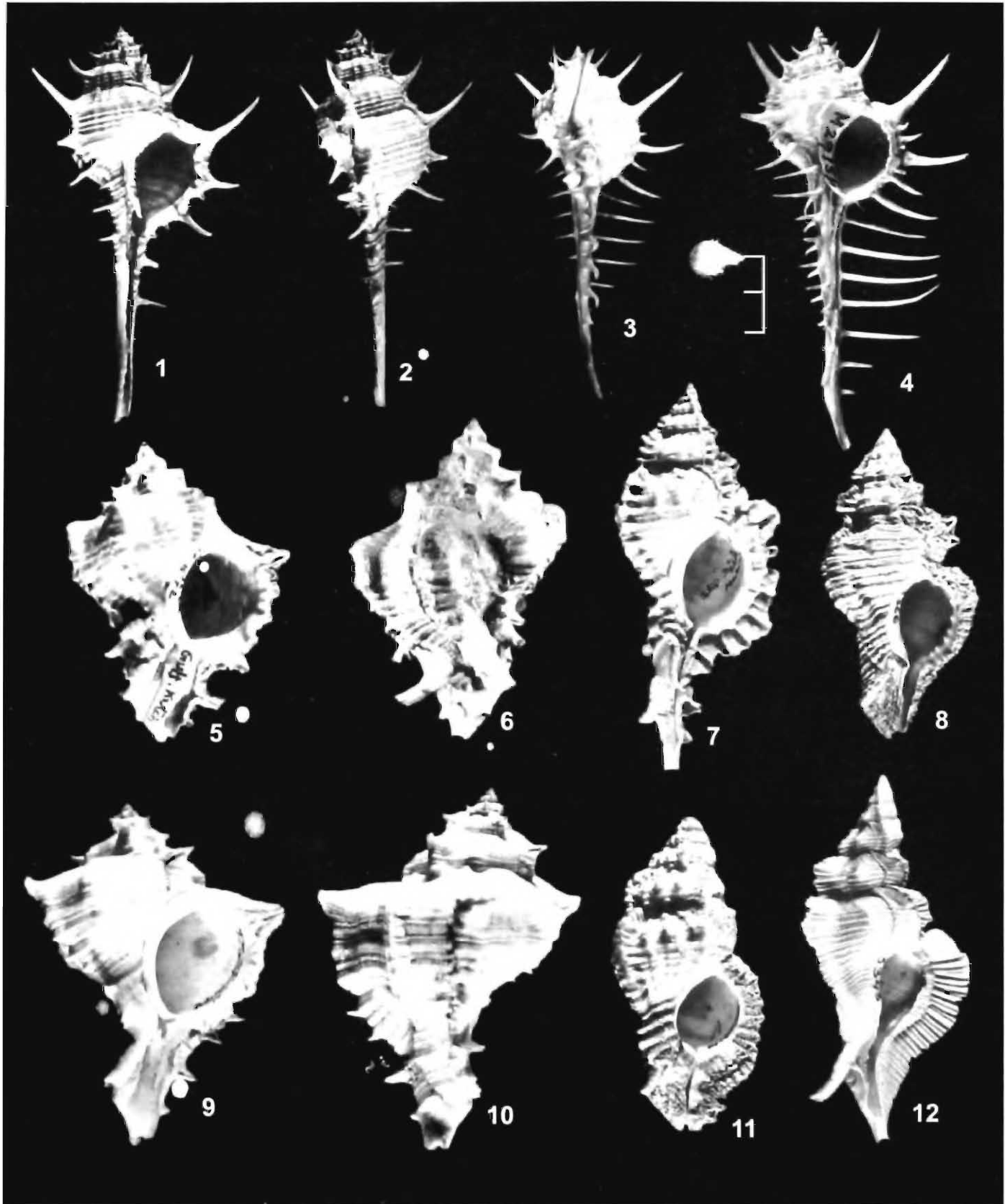
1. *Chicoreus microphyllus*; 2. *Chicoreus brunneus*; 3. *Chicoreus kilburni*; 4. *Chicoreus axicornis* : Andamans, M2913/1, 56.4 x 35(with spines) 0/19(without spines); 5. *Chicoreus banksi* : Andmans, M 3364/1, 54.25 x 30.35(with spines)/ 19.5(without spines); 6. *Chicoreus ramosus*.

Plate 53 : Muricidae



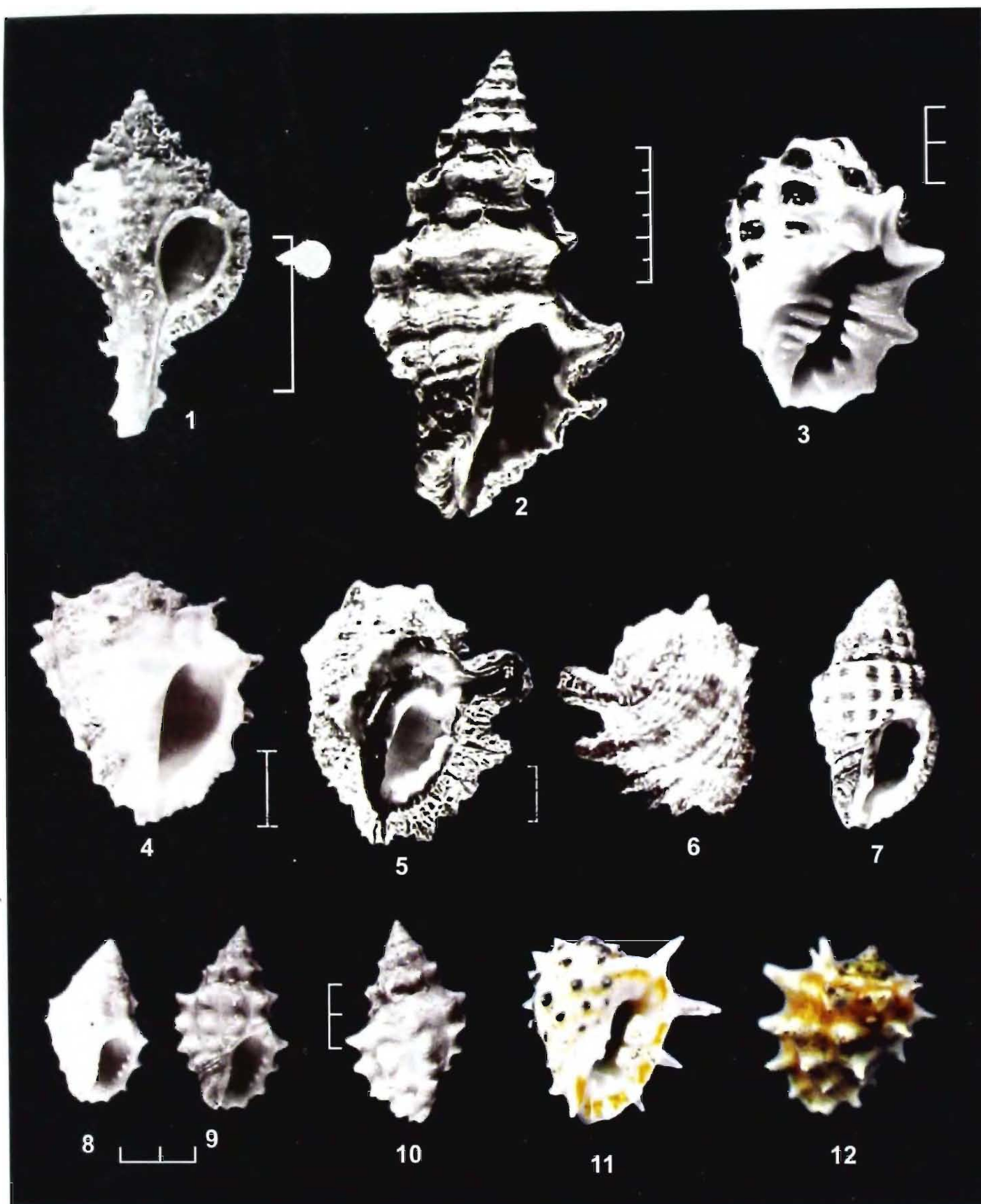
1. *Haustellum haustellum* : Andamans. 2. *Homalocantha scorpio* : Andamans. 3. *Homalocantha secunda* : Sri Lanka. 4,5. *Murex carbonnieri*; 6, 7. *Murex malabaricus*; 8,9. *Murex tenuirostrum* ; 10. *Murex tribulus* : Port Okha, Gujarat.

Plate 54 : Muricidae



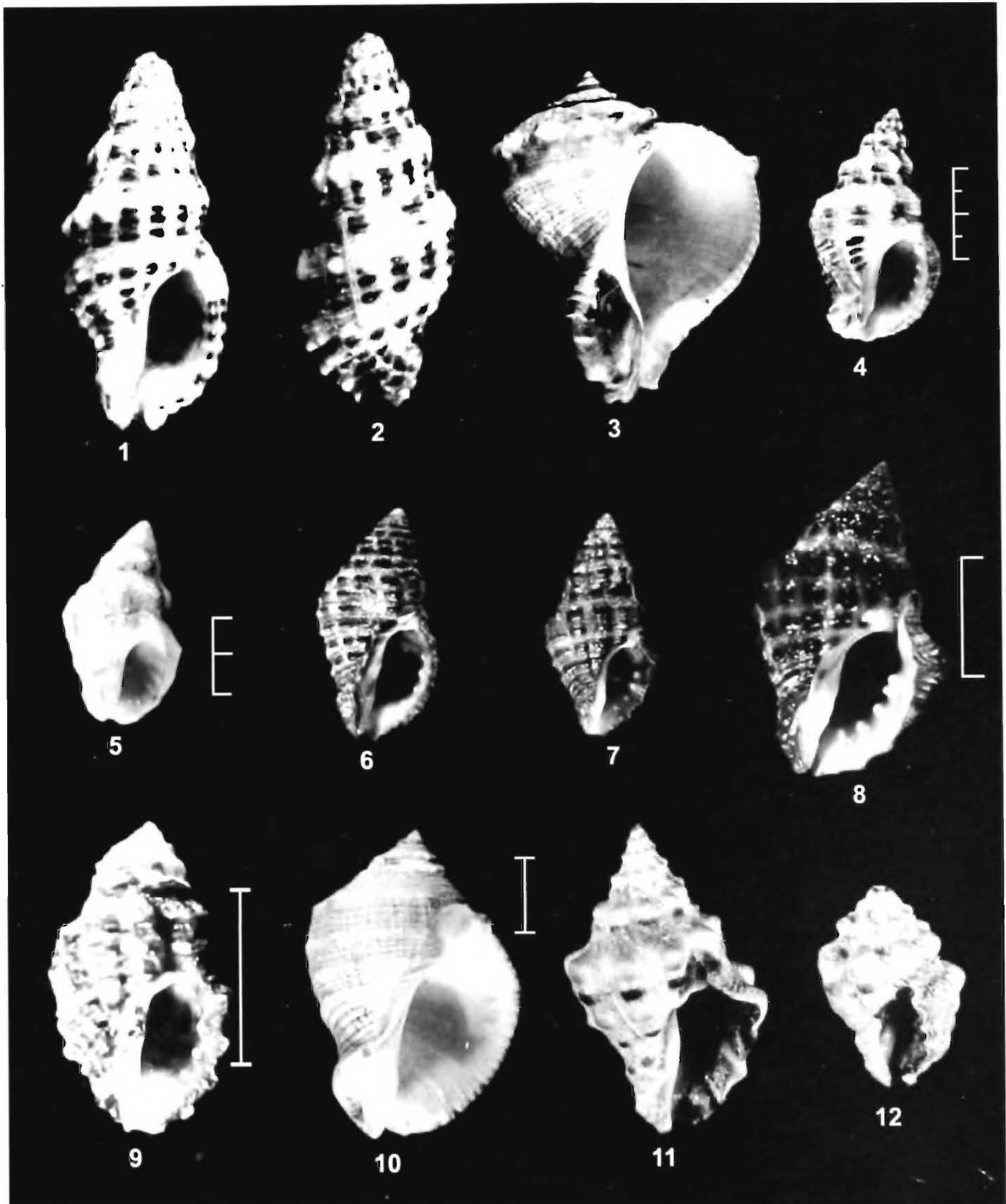
1,2. *Murex trapa* : Visakhapatnam; 3,4. *Murex ternispina* : Andamans; 5,6. *Muricanthus kuesterianus*; 7. *Naquetia amandalei* : Andaman Sea; 8. *Naquetia capucina* : Arakan, Mynmar; 9,10. *Muricanthus virgineus*; 11. *Naquetia triqueter* : Andamans; 12. *Pterynotus pinnatus*.

Plate 55 : Muricidae



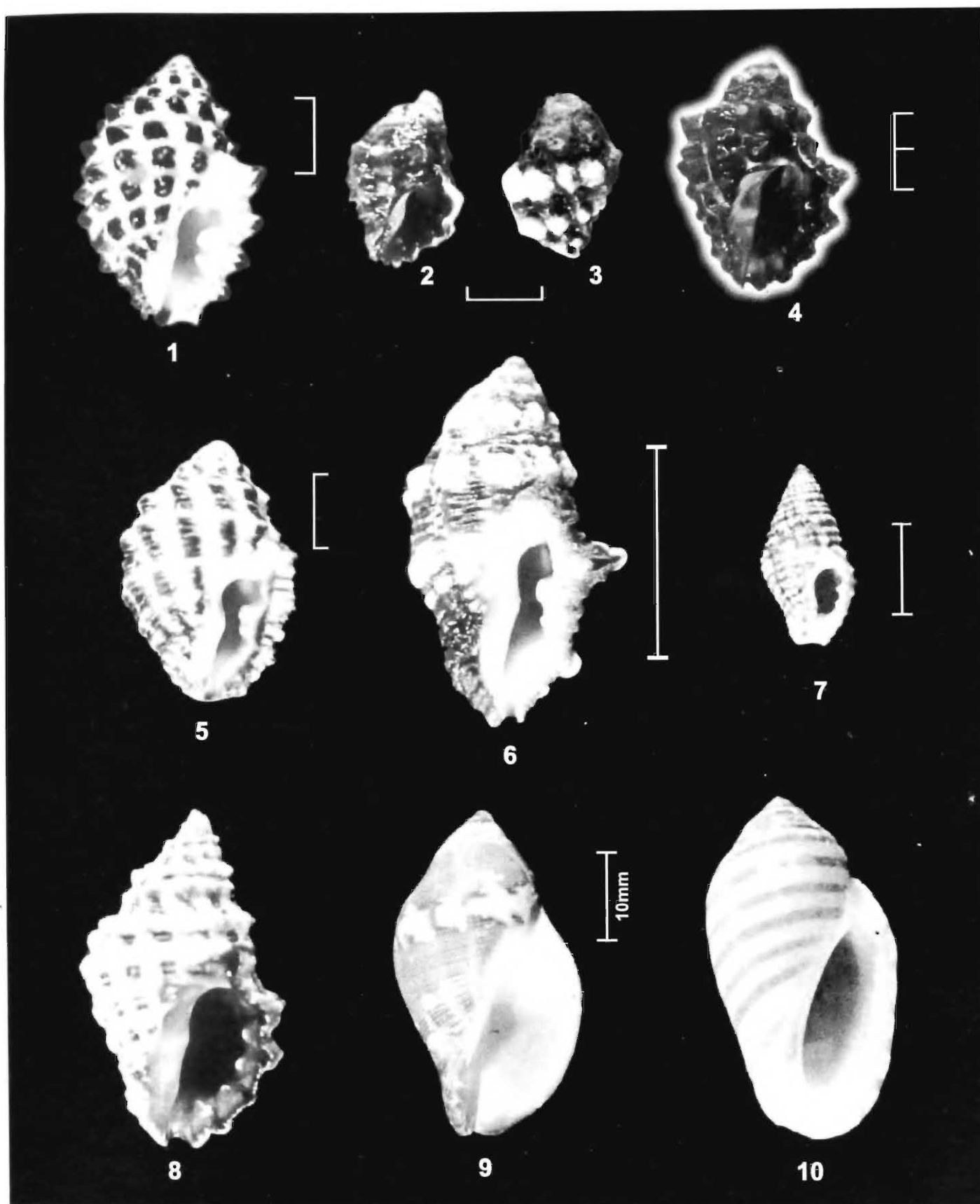
1. *Murexiella andamanensis* : Holotype, Andamans, 13.1 x 7.35mm; 2. *Muricopsis bombayensis* : Gujarat; 3. *Drupa morum morum* : M 21501/4, Arong village, Car Nicobar; 4. *Drupa rubusidaeus* : Sri Lanka; 5,6. *Drupa lobata*; 7. *Drupella concatenata* : M3580; 8-10. *Drupella cornus* : Mauritius; 11,12. *Drupa ricinus ricinus* : Neil Island, South Andaman. 21.5x16 mm.

Plate 56 : Muricidae



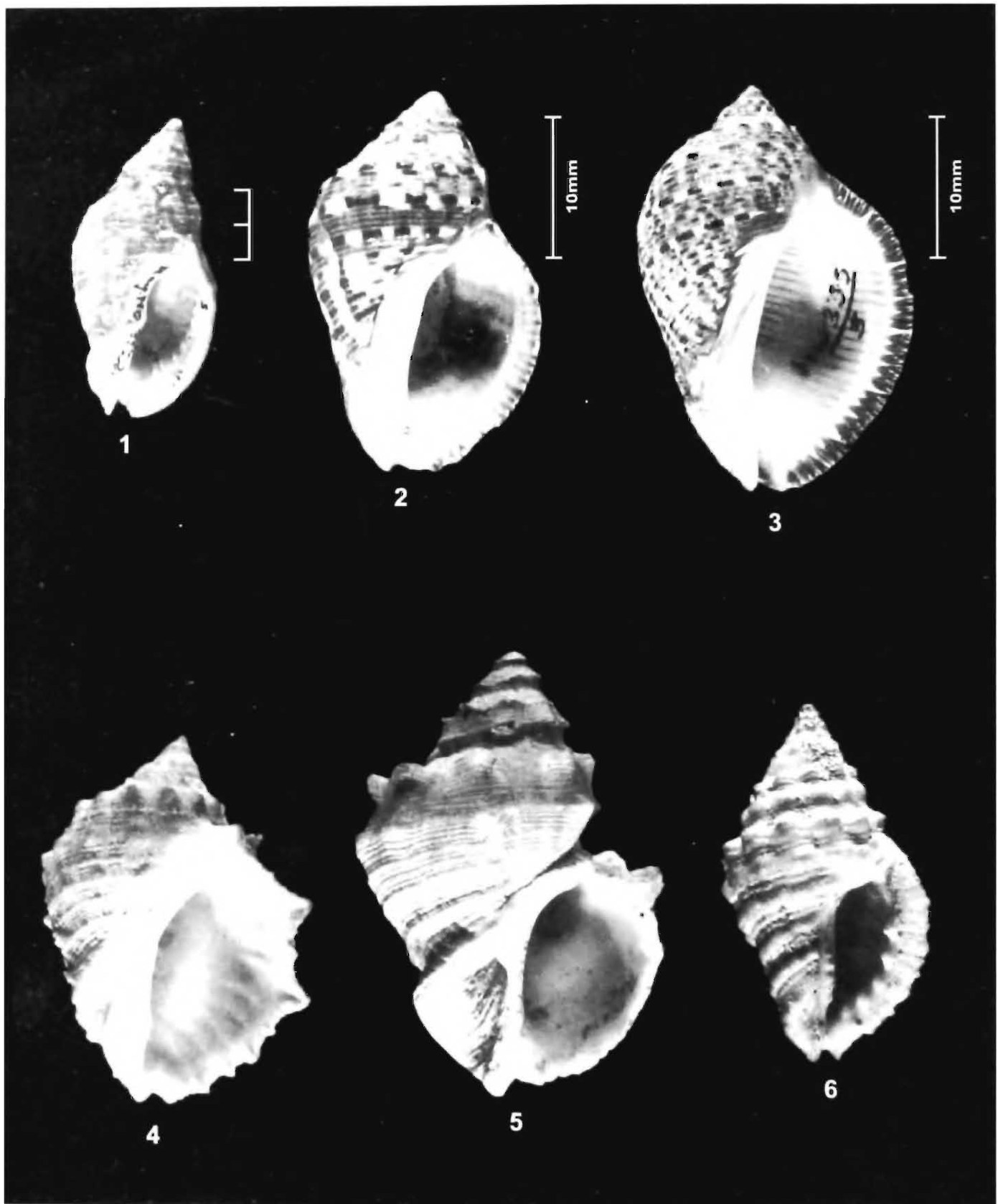
1,2. *Maculotriton serriale*; 3. *Rapana rapiformes* : India; 4. *Cronia contracta* : M 22432/4, 31.5 x 16.9, Tuticorin harbour, Tamil Nadu; 5. *Cronia ochrostoma* : M 19181/3, 19.05 x 11.4; 6. *Cronia konkanensis* : M 17252/3, 21.5 x 12.5; 7. *Cronia subnodulosa* : M22489/4 2045 x 10.8; 8,9. *Morula granulata* : Dolphin's Nose, Visakhapatnam, Andhra pradesh, 23.5x14.8; 10. *Mancinella bufo* : Canacona, Goa; 11,12. *Morula anaxeres*.

Plate 57 : Muricidae



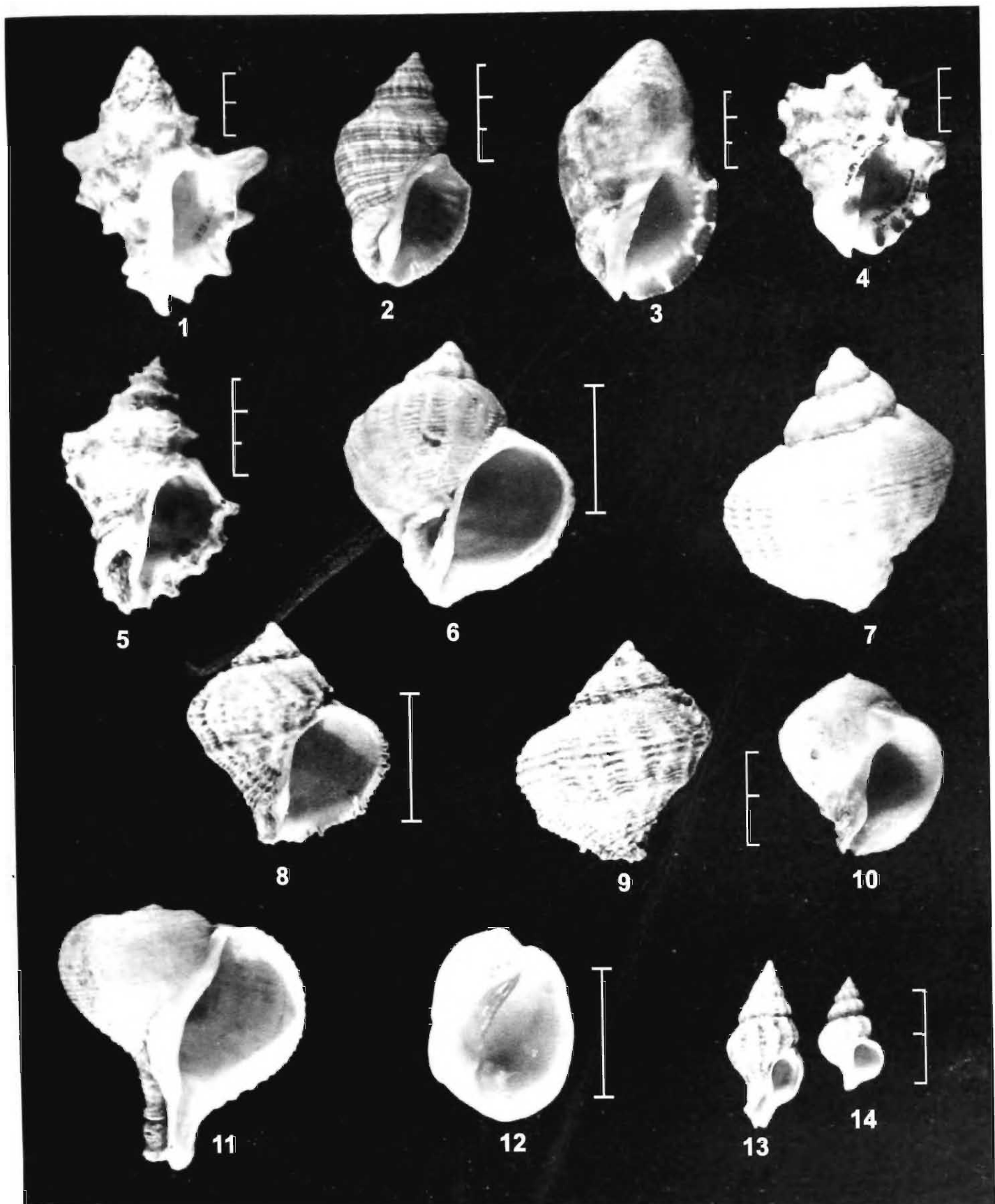
1. *Morula uva* 3568, Mauritius; 2,3. *Morula nodicostata* : Tamalu Village, Car Nicobar, 9.6x6.6, and 8.6x5.4; 4. *Thais hippocastanum* : Aberdeen Bay, Port Blair; 5. *Morula uva*: Mauritius, 22.65x15mm; 20.7x14mm; 6. *Morula biconica* : India, M 3578, 20.7x10.7; 7. *Morula funiculata* : Mergui Archipelago, 9x4.7.7; 8. *Morula marginatra* : Indian Seas, M.3567, 21.5x12.35; 9. *Nassa sarta* : Car Nicobar; 10. *Vexilla vexillum* : Bombay, M 19163/3, 18.2 x 9.9, scale bar 5mm.

Plate 58 : Muricidae



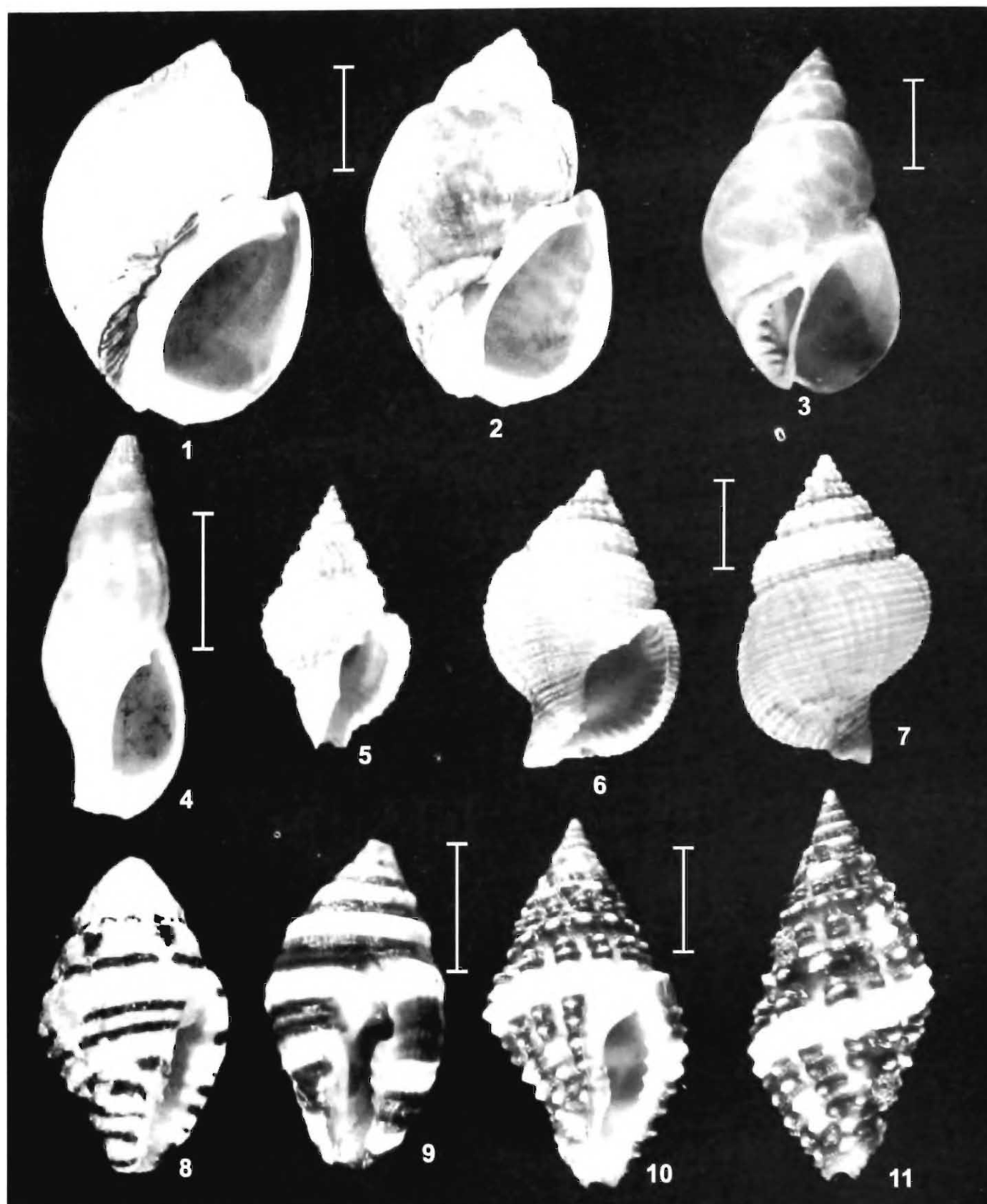
1. *Purpura buccinea* : M 3522, 43.65 x 20.85; 2. *Purpura panama*, Bey Id. Gujarat; 3. *Purpura persica* : Andamans; 4. *Thais echinata* : Andamans; 5. *Thais lacera* : Malpe, South Kanara, Karnataka; 6. *Thais tissoti* : Cumta beach, North Kanara dist. Karnataka.

Plate 59 : Muricidae



1. *Thais armigera* : Andmans, M 3525, 65.6 x 48.9 (excluding spines); 2. *Thais blanfordi* : M 24119/5, 25 x 15.55; 3. *Thais intermedia* : Andamans, 47 x 30 mm; 4. *Thais tuberosa* : Neil Id, M 24118/5, 46.5 x 43.5 (with spine) / 36.7 Excluding spine; 5. *Thais rugosa* : Black Pagoda, Konark, Orissa, M 4321/1, 30.7 x 19.55; 6-9. *Coralliophila erosa* : Indian Seas, M 3605; 10. *Coralliophila neritoidea* : M 3607; 11. *Rapa rapa* : M3562; 12. *Coralliophila madreporara* : Andamans; 13. *Coralliophila costularis* : M 332; 14. *Coralliophila abnormis* : M 3613.

Plate 60 : Buccinidae



1, 2. *Babylonia spirata* : Madras, M 19283/3; 3. *Babylonia zeylanica* : Visakhapatnam, 3623;
 4. *Pisaneia ignea* : Indian Seas, M 3435; 5. *Nassaria coromandelica*; 6,7. *Nassaria laevior* : Holotype
 8. *Engina lineata*; 9. *Engina mendicaria* : Nicobars; 10,11. *Engina alveolata* : Andamans.

Order NEOGASTROPODA

Shell is solid and usually large. It is variously sculptured and has a prominent anterior siphonal canal. An operculum is present in many. Proboscis mainly is pleurembolic. Radula has a central and pair of lateral or marginal teeth. Mantle cavity contains a single monopectinate gill, one auricle and one kidney. Sexes are separate with a complex reproductive system. All occur in marine habitats with the exception of a few estuarine inhabitants. These are mainly carnivores or scavengers.

The order includes 21 families and about 5000 species. 19 families and an estimated 500 species are reported to occur in India.

Family MURICIDAE

Shell is very small to very large in size, measuring 5 mm to 300 mm in height. It is variable in shape, elongate or fusiform to club-shape or biconic. Spire is distinct and usually of medium height. Protoconch consists of a few whorls. Aperture is rounded to ovate. Columella is without folds but often may bear plicae. Outer lip may be dentate and sometimes may bear long processes. Anterior siphonal canal is short to long, narrowly open or entirely closed. Posterior canal is not distinct. Surface is scabrous or lamellose, or may bear simple, foliated or spiny varices. Axial sculpture may consist of one or a few ridges or knobs. Aperture is closed by a thin or thick operculum. It is unguiculate, ovate or rounded.

Cephalic tentacles are pointed and bear eyes at their outer bases. Foot is moderately long and bears a special accessory-boring organ located on the midanterior ventral surface. There is a short to long siphon. Mantle cavity contains a monopectinate ctenidium, a well-developed bipectinate, chemosensory osphradium and a hypobranchial gland that produces purple secretion. Proboscis is moderately long and extensible. Alimentary system has a pair of salivary glands, with a pair of smaller accessory salivary glands lying dorsal to the pharyngeal bulb. Oesophagus has a posterior valve of Leiblein. A true anal gland is present in the form of a caecal outgrowth from the rectum. Radula is long and stenoglossate (1-1-1).

Sexes are separate. Penis is situated just behind the right tentacle. It is wide, blunt and dorso-ventrally flattened, with a flagellum at the tip. Development usually is direct and a few species have pelagic larva. Eggs are laid in capsules that form a cluster and are attached to shells or seaweeds. A cluster may consist of 25 to 80 capsules and each capsule may contain about 19 to 700 eggs. Some of the eggs develop into embryos while some serve as nurse eggs.

Muricids have worldwide distribution and are abundant in intertidal zone of rocky coast and reef ecosystem. Majority of the species occur in littoral and sublittoral zones while a few extend to a depth of about 1900 m. Muricids are carnivores mainly feeding upon barnacles, other molluscs, polychaetes, crustaceans, small fish *etc.*

The family includes about 800 species, which are grouped under eight subfamilies, namely Muricinae, Muricopsinae, Ocenebrinae, Trophoninae, Typheninae, Drupinae, Thaidinae and Rapaninae. Only Ocenebrinae is not reported from India.

There is no unanimity with regard to division of the family into subfamilies. We have followed the one given by Boss (1982) and Radwin and D'Attilio (1976). Recent studies have recognized eight subfamilies : Muricinae, Muricopsinae, Typhinae, Tripterotyphinae, Erglataxinae, Ocenebrinae, Rapaninae and Trophoninae. The subfamilies Thaidinae and Drupinae are clubbed together with Rapaninae. The subfamily Erglataxinae includes the genera, *Cronia*, *Vexilla* and *Vitularia*.

Subfamily : MURICINAE

Shell is small to very large in size, fusiform or globose, ornamented with simple foliated or spinose varices, axial sculpture with one to a few ridges or knobs, the inner side of outer lip dentate or lirate or rarely smooth, siphonal canal may be long, narrow and tubular or broad and short or partly sealed in some. Operculum is unguiculate, marginally thick with a central depression and a terminal or subterminal nucleus.

It is a large subfamily, which includes some of the common murex shells found along Indian coasts. About 180 species belonging to 28 genera are known worldwide; 44 species and 9 genera are reported from India.

Chicoreus axicornis (Lamarck, 1822)

(Pl. 52, fig. 4)

Shell small to medium in size, 20 to 50 mm in length. Protoconch smooth, consists of 2 ½ whorls, spire high with 8 post nuclear whorls, body whorl small, suture deep. Aperture ovate, anal sulcus inverted U-shape, outer lip dentate, interior lirate, inner lip detached, siphonal canal long and slightly curved. Body whorl sculptured with three varices and foliaceous spines, two prominent axial ridges in between the varices, shoulder spine largest, siphonal canal with two moderately long spines. Colour light brown with interior of aperture white.

India : Andamans. Elsewhere: Persian Gulf, Sri Lanka, Taiwan, Philippines.

Chicoreus banksii (Sowerby, 1841)

(Pl. 52, fig. 5)

Shell small to medium in size, 28 to 56 mm in length, fusiform, protoconch smooth, consists of 2 ½ whorls, spire high with seven post nuclear whorls, sutures deep, body whorl of moderate size. Aperture ovate, outer lip crenulated above but dentate below, columella slightly adherent posteriorly but detached anteriorly, siphonal canal long and narrowly open, distally curved

upwards. Body whorl sculptured with three foliaceous varices and two prominent axial knobs **on the shoulder**, with major and minor spiral cords, and nodules, shoulder spine longest followed **by one shorter**, and three of equal length and another shorter spine, distally curved, siphonal canal with three larger spines.

India : Maharashtra: Bombay; Andamans. Indo-Pacific.

***Chicoreus brunneus* (Link, 1807)**

(Pl. 52, fig. 2)

Shell medium to large in size, 47 to 80 mm in length, generally thick and rhomboid, protoconch smooth, depressed, with 2 ½ whorls, black coloured, spire elevated with seven post-nuclear whorls. Aperture small, ovate, anal sulcus narrowly deep, outer lip finely dentate, interior lirate, columella adherent posteriorly but detached anteriorly, smooth, with a blunt tooth posteriorly, siphonal canal short, broad (narrowly closed) and distally curved. Body whorl large, sculptured with profusely frilled varices, a single large blunt knob axially in between the varices, spiral sculpture with major and minor cords bearing fine tubercles, varices with branched and foliate spines, shoulder spines long followed by seven short spines, canal with three spines. Colour dark chestnut brown to black, with white aperture and yellow or dark, purple-blue columella.

India : East and West Coasts, Andaman and Nicobar Islands, very common. Tropical Indo-Pacific.

Synonym : *Murex adustus* Lamarck, 1822.

***Chicoreus kilburni* Houart and Pain, 1982**

(Pl. 52, fig. 3)

Shell medium to large in size, 40 to 92 mm in length, broadly rhomboidal, protoconch smooth with 2 ½ whorls, terminally depressed like a cavity, spire elevated with seven to eight post nuclear whorls, body whorl large. Aperture large, ovately rounded, anal sulcus inverted V-shape, outer lip dentate, interior lirate, columella adherent but anteriorly slightly detached, siphonal canal medium-sized, broad, narrowly open and recurved upward towards right. Body whorl sculptured with three varices, two to three axial ribs, one on shoulder prominent and knob-like, spiral sculpture with major and minor cords bearing fine nodules, with prominent frondose spines on the varices of the body whorl, shoulder spine large and branched, followed **by four equal sized spines** enclosing spinelets in between, canal with three spines. Colour light brown to chocolate brown with dark pink ribs, aperture white on the interior bearing a large parietal pink patch.

India : Gujarat, Maharashtra: Bombay; Andaman and Nicobar Islands. Indian Ocean.

Synonym : *Murex maurus* of authors.

Chicoreus microphyllus (Lamarck, 1819)

(Pl. 52, fig. 1)

Shell large, up to 92 mm in length, fusoid shape, protoconch smooth, rounded and depressed with 2 ½ whorls, spire high, consists of nine post nuclear whorls, body whorl large and elongate. Aperture circularly ovate, anal sulcus narrow and deep, outer lip thick, dentate, lirate interiorly, columella adherent, slightly twisted with faint plications on the posterior part, siphonal canal of moderate size, narrowly open, terminal part curved to the right. Body whorl sculptured with foliaceous varices, short and broadly open spines, shoulder spines large followed by four short spines and with spinelets in between, four spines on the canal, one to two knob-like axial ridges, spirally with primary and secondary cords bearing fine tubercles giving a scabrous surface. Colour light to dark brown with white aperture tinged with light pink.

India : Orissa : Gopalpur; Tamil Nadu : Madras; Andamans. Indo-Pacific.

Synonym : *Murex torrefactus*, Sowerby, 1841.

Chicoreus ramosus (Linnaeus, 1758)

(Pl. 52, fig. 6)

Shell large to very large in size, up to 254 mm in length, fusiform, protoconch rounded and smooth, 2 ½ whorls, spire low, consists of six rounded whorls, suture impressed, body whorl large and globose. Aperture large, ovately rounded, anal sulcus shallow and broad, with a parietal ridge, outer lip with coarse dentations and a prominent tooth on the lower half, inner side lirate, columella detached anteriorly but partly adherent posteriorly forming a callus, siphonal canal of moderate size, broad and narrowly open. Body whorl with three varices bearing foliaceous spines in between, prominent axial ridges, spiral cords and threads, shell surface scabrous. Shoulder spine prominent followed by five of equal length, with spinelets in between, canal with three spines decreasing in size anteriorly. Colour light brown to dark with pinkish tinge on spiral cords, aperture interiorly with reddish pink margin.

India : Gujarat, Tamil Nadu : Gulf of Mannar (Tuticorin); Pondicherry, Andhra Pradesh : Visakhapatnam; Andaman and Nicobar Islands. Indo-West Pacific.

The species possesses the largest sized shell in the family and occurs at a depth of 15 to 20 m. In Port Blair, Andamans, it is commonly known as Nancowry Shell, probably because of its abundance in Nancowry group of islands. Nowadays the shellcraft market in Port Blair mainly survives on the shells obtained from the Gulf of Mannar, Tamil Nadu. About 272.8 tons in 1992 and 537.1 tons in 1993 were fished from Southeast India (Ayyakkannu, 1994).

***Haustellum haustellum* (Linnaeus, 1758)**

(Pl. 53, fig. 1)

Shell large, up to 90 mm in length, club shaped, protoconch smooth, with 2 ½ whorls, low spire consists of six subangulated whorls, body whorl inflated, globose, suture impressed. Aperture wide, subcircular, anal sulcus U-shaped, outer lip thickened with a thin projection over it, inner surface with 12 to 15 lirations, inner lip a little adherent posteriorly but completely detached anteriorly, erect and raising above the plane of the canal, inner surface smooth, outer surface strongly and irregularly ridged, siphonal canal longer than the body whorl and spire combined, straight, tapering anteriorly, almost closed, without spines. Body whorl with three rounded varices, three to four broad and low axial ridges, prominent on shoulder, spiral sculpture with five to eight primary cords followed by fine threads in between, canal bears eight primary cords with fine threads in between. Colour light brown with distinct chocolate brown on cords and tubercles, aperture with pale pink margin on its interior.

India : Tamil Nadu, Andaman and Nicobar Islands. Indo-Pacific.

***Homalocantha scorpio* (Linnaeus, 1758)**

(Pl. 53, fig. 2)

Shell moderately large, up to 54 mm in length, fusiform, spire elevated, consists of four whorls, shouldered, suture deeply excavated. Aperture small, subcircular, outer lip finely dentate, inner lip detached, smooth, without anal sulcus, siphonal canal long, narrowly open, body whorl with five varices, bearing short spines except on the last varix, which bear four long spines, distally palmate and digitate, ventrally open, connected by webbing, spirally with major and minor cords alternating each other. Colour dark pinkish brown, with light interior.

India : Known only from Andamans. Red Sea to Philippines.

***Homalocantha secunda* (Lamarck, 1822)**

(Pl. 53, fig. 3)

Shell smaller than in the preceding species, up to 40 mm in length, broadly fusiform, spire less elevated than in the preceding species, five shouldered whorls, suture deep, obscured by succeeding whorl. Aperture small, oval, without anal sulcus, outer lip dentate, inner lip adherent, slightly detached anteriorly, smooth, siphonal canal long, broad, narrowly open. Body whorl with five to six varices, last varix with five digitate and distally palmate spines, canal with three long spines enclosing smaller spines in between and connected by a web. Colour light brown to chestnut brown, interior white.

India : Tamil Nadu. Elsewhere : Sri Lanka to New Caledonia.

***Murex carbonnieri* (Jousseaume. 1881)**

(Pl. 53, fig. 4, 5)

Shell large, up to 100 mm in length, club shaped, spire elevated, acute, consists of 7 to 9 whorls, suture deep, simple, crossed by growth lamellae. Aperture ovate, outer lip margin crenulated, a small labial tooth on the lower part, inner lip partly adherent posteriorly but detached anteriorly, siphonal canal tubular, straight, narrowly open. Body whorl large, with three prominent varices bearing long spines, shoulder spine longest and open, sculpture consists of several primary and secondary spiral cords. Colour creamy white to light brown. Spiral cords with lighter nodes enclosing elongated brown spots in between. Aperture with brown spots on notches.

India : East and West Coasts, Lakshadweep, Andaman and Nicobar Islands, common. Indo-West Pacific.

The species closely resembles *Murex tribulus*, but can be differentiated from the latter by the presence of reddish brown spots on its primary cords.

Synonym : *Murex tribulus* of authors (part)

***Murex malabaricus* Smith, 1894**

(Pl. 53, fig. 6, 7)

Shell large, up to 115 mm in length, spindle shaped, spire elevated, acute, consists of eight whorls. Aperture ovate, without anal sulcus, outer lip crenulated, interior slightly lirate, inner lip slightly adherent posteriorly but detached anteriorly, siphonal canal elongate and narrowly open. Body whorl large, bears three varices, three to six low axial ridges, spiral sculpture consists of about 22 primary, secondary and tertiary cords. Primary cords at the intersection with varix give rise to short, open, recurved spines, shoulder spine largest, spines connected by web. Colour light brown with three dark transverse bands on the body whorl. Aperture white with light pinkish colour inside.

India : Gujarat, Maharashtra, Karnataka, Kerala. Arabian Sea. A single record from Bay of Bengal.

***Murex tenuirostrum tenuirostrum* Lamarck, 1832**

(Pl. 53, fig. 8, 9)

Shell large, up to 92 mm in length, club shaped, whorls elevated, suture shallow, curved axial rib on the last whorl demarcates it from the teleoconch, spire acute, consists of 8 to 10 whorls, whorls rounded but looks angulated because of the prominent primary cord. Aperture oblong, outer lip crenulated, lirate inside, a prominent labial tooth on the lower half, inner margin posteriorly adherent but detached anteriorly, canal very long, straight and narrowly open.

Sculpture consists of spiral and axial cords and ribs, three rounded varices bearing spines at the intersections of spiral cords, spines closed, curved and solid. Colour creamy white, aperture white.

India : Kerala, Tamil Nadu: Madras, Tranquebar; Andamans, deep-water form. Indo-Pacific.

It differs from *Murex tribulus* and *M. ternispina* in possessing a very long siphonal canal bearing very few short spines.

Synonym : *Murex tribulus* of authors (part)

***Murex ternispina* Lamarck, 1822**

(Pl. 54, fig. 3, 4)

Shell of medium to large size, up to 95 mm in length, club shaped, spire low, with two whorls but with eight to nine whorls including protoconch, suture deep, crossed by growth lamellae, body whorl large and globose. Aperture ovate, outer lip margin with strong varix with three large and about six intervening small teeth, interior lirate, inner lip partly adherent posteriorly, erect anteriorly, canal straight and long, opens narrowly. Surface sculptured with spiral cords and axial ribs, cords include primary and secondary ones separated by threads, three spines on each whorl, shoulder spine long and prominent, generally straight, spines solid, closed, terminally curved, and decrease in size gradually from posterior to anterior side, canal with curved spines, axial sculpture consists of longitudinal rounded ribs in between varices. Operculum thin, horny, reddish brown. Colour creamy white and aperture also white.

India : Gujarat, Orissa, Andamans. Indo-Pacific.

It is characterised by discontinuous axial ribs and dark purple coloured spinal tips.

Synonym : *Murex nigrispinosus* Reeve, 1845

***Murex trapa* Roeding, 1798**

(Pl. 54, fig. 1, 2)

Shell medium to large in size, up to 93 mm in length, whorls consist of seven post nuclear and 2 ½ in the protoconch, a prominent spiral ridge on the base of the protoconch, which continues as shoulder ridge on teleoconch, spire moderately elevated, acute, body whorl large, rounded. Aperture large and lenticular, anal sulcus broad and deep, outer lip erect and crenulated, smooth anteriorly, a large prominent labial tooth, inner lip adherent posteriorly, detached and with callus anteriorly, siphonal canal elongate, straight and narrowly open. Sculptured with three rounded and spinose varices, axial sculpture with four to five intervarically low costae, spiral cords include primary, secondary and tertiary ones, spines moderate to short, closed

ventrally, curved upwards on body and straight on canal. Colour light brown, aperture white, margin deep brown in the middle.

India : East Coast, Andamans, not reported from West Coast. Indo-Pacific.

It resembles *M. tribulus* but differs from it in its elevated and acute spire, subangulate whorls, and in having a few spines on upper part and a more prominent labial tooth.

***Murex tribulus* Linnaeus, 1758**

(Pl. 53, fig. 10)

Shell large, up to 112 mm in length, club-shaped, protoconch of 3 ½ whorls, smooth except for a spiral ridge on the last whorl, spire high consisting of six to seven rounded whorls, sutures deep and compressed, body whorl globose. Aperture large, subcircular, anal sulcus broad and shallow, outer lip erect with crenulations on the lower part united to form a labial tooth, inner lip detached and erect anteriorly but slightly adherent posteriorly, siphonal canal elongate, narrowly open, straight and distally curved. Sculptured with three spinose varices on the body whorl, with three to four strongly nodose axial costae, spiral sculpture consists of three primary cords enclosing in between secondary and tertiary cords, with long and straight spines on the primary cords and short spines on the secondary cords, siphonal canal generally with seven spines, which decrease in size towards the anterior end. Surface colour light brown with white aperture, tips of spines tinged with dark purple.

India : East and West Coasts, Andamans, common. Indo-West Pacific.

The species resembles *Murex trapa*, but can be differentiated from it in possessing more spines on the entire length of the canal and blunt labial teeth.

***Muricanthus kuesterianus* (Tapparone-Canefri, 1875)**

(Pl. 54, fig. 5, 6)

Shell moderately large, up to 62 mm in length, broad, spire low with five angular whorls, suture not distinct, body whorl large and globose. Aperture large, ovate, outer lip strongly dentate and lirate on the interior, a prominent labial tooth on the lower part, inner lip adherent, smooth and twisted anteriorly, siphonal canal short, broad and distally curved. Body whorl bears seven to eight rounded cords, shoulder region with prominent spine, with a cluster of spines near the anterior end, canal with a very large and stout spine.

India : Gujarat, Maharashtra : Bombay. Arabian Sea.

The shell bears close resemblance to that of *M. virgineus* but can be differentiated by its general shape and distinct sculpture.

Synonym : *Murex virgineus* : Subrahmanyam *et al.* (1952) and Menon *et al.* (1961).

Muricanthus virgineus (Roeding, 1798)

(Pl. 54, fig. 9, 10)

Shell medium to large in size, up to 118 mm in length, fusiform, spire acute with six to seven subangulated whorls, body whorl large, globose. Aperture large, ovate, anal sulcus shallow, inverted U-shape, outer lip thick, with coarse denticles and a prominent tooth on the lower part, inner lip adherent, anterior most part slightly twisted, smooth but with a parietal ridge, siphonal canal not much elongate, broad, distally curved upwards. Sculpture consists of four rounded varices on body whorl, spiral sculpture consists of six to seven major cords with minor cords and fine scabrous threads in the interspaces, a few short, open spines at the intersection of major cords with varices, the prominent one being on the shoulder, spines on the lower part of the body whorl develop into a wing-like structure, canal with two spines. Colour light cream with a pinkish or chocolate brown band on the middle of the body whorl, aperture marble white with a reddish pink margin.

India : Tamil Nadu: Gulf of Mannar, common. Indian Ocean.

Shell resembles that of *Murex ramosus* but can be differentiated from it by the presence of four varices on body whorl and indistinct foliaceous spines on the varices. It can be differentiated from *M. kuesterianus* in having fewer numbers of varices, an axial knob and a prominent shoulder spine.

Naquetia annandalei (Preston, 1910)

(Pl. 54, fig. 7)

Shell large, up to 83 mm in length, fusiform, spire high and acute, with seven subangulate whorls, suture impressed, body whorl large, fusiform. Aperture lenticular, anal sulcus shallow inverted U-shape, outer lip thick, lirate on the inner side, inner lip smooth, siphonal canal long, moderately broad, distally curved to the right. Sculptured with three frondose varices on the body whorl, varical webbing overlaps the preceding whorl, two to three prominent axial knobs on the shoulder; spiral sculpture consists of ten primary cords in between with secondary and tertiary cords. Colour light brown with three dark reddish brown spiral bands on the body whorl and a single spiral band on each of the spirel whorl, aperture white with a light pinkish patch.

India : Orissa, Andaman Sea. Indo-West Pacific.

Naquetia capucina (Roeding, 1798)

(Pl. 54, fig. 8)

Shell moderately large, up to 66 mm in length, fusiform. spire high and acute, with six subangulate whorls, suture not distinct, body whorl medium-sized, fusiform. Aperture ovate,

anal sulcus deep inverted V-shape, outer lip thick, coarsely dentate, inner side with seven prominent denticles, inner lip smooth, with a prominent knob on the posterior end, siphonal canal short and broad, distally curved to the right. Sculptured with three rounded, thick varices thrown into a number of folds, laminate, with one to two low axial ridges in between the varices, spiral sculpture consists of alternating major and minor cords, body surface with low folds or frills which become prominent on the canal. Colour dark chestnut brown, aperture white with light pink margin.

India : Andaman and Nicobar Islands, near mangroves. Elsewhere: Singapore, Western Australia to Philippines.

***Naquetia triqueter* (Born, 1778)**

(Pl. 54, fig. 11)

Shell smaller than in the other two species of the genus, up to 56 mm in length, narrow and fusiform, spire high with five whorls, sutures obscure, body whorl of moderate size. Aperture large, ovate, anal sulcus broad and shallow, outer lip finely crenulated, inner lip smooth, siphonal canal short and broad. Body whorl with three rounded and thick varices, three low elongated axial ridges between varices, spiral sculpture consists of eleven major cords enclosing in between two to three fine threads, varix develops into webbing anteriorly, posteriorly overlaps the preceding whorl. Colour creamy brown with two to three dark brown spiral bands on the body whorl and blotches on the rest. Aperture white.

India : Andamans, not common. Tropical Indo-Pacific.

***Pterynotus pinnatus* (Swainson, 1822)**

(Pl. 54, fig. 12)

Shell moderately large, up to 67 mm in length, fusiform, spire high with six to eight whorls, suture shallow, body whorl large. Aperture broad and ovate, anal sulcus indistinct, outer lip with fine crenulations and lirations, inner lip smooth, siphonal canal of moderate size. Body whorl with three varices expanded into thin flanges continuing along the body and canal, ventrally scaly in appearance, a single low, knob-like axial ridge prominently on the shoulder in between the varices, spiral sculpture consists of numerous threads, in between with minor cords, a spine-like projection on the siphonal canal. Colour white to light fawn with brown patches on the wing, aperture white.

India : Tamil Nadu : Porto Novo, Madras; Andamans. Tropical Indo-Pacific, moderately common.

Subfamily MURICOPSINAE

Shell is small to medium in size, fusiform to biconic, ornamented with prominent varices bearing foliaceous or spine-like projections, gap between body and canal without sculpture, axial sculpture consists of fine lamellae, anal sulcus weak, siphonal canal of moderate length. Operculum as in the subfamily Muricinae.

Four genera, each represented by a single species, are reported from India.

Murexiella andamanensis Houart and Surya Rao, 1996

(Pl. 55, fig. 1)

Shell small, up to 14 mm in length, spire acute, high with four angulated whorls, suture impressed, body whorl globose. Aperture oval, anal sulcus indistinct, outer lip margin crenulated, inner lip smooth, siphonal canal moderately long, narrowly open. Body whorl with seven to eight frilled spinose varices, shoulder edge with prominent, upwardly curved spines, spiral sculpture consists of five major cords on the body whorl, and two on each of the spire whorl, upwardly curved, open spines in the interstices, canal with two prominent spines. Colour light brown.

India : Andamans.

Synonym : *Murexiella macgintyi*: Subba Rao and Surya Rao, 1993 (*non* : M. Smith, 1938)

Muricopsis hambayanus (Melvill, 1893)

(Pl. 55, fig. 2)

Shell small, up to 35 mm in length, fusiform, spire acute and longer than body whorl including siphonal canal, with five to six angulated whorls, suture impressed. Aperture oval, anal sulcus broad, U-shaped, outer lip margin feebly crenulated, with six teeth on the inner margin, lip smooth with two to three pustulae on the anterior end, siphonal canal short and open. Sculptured with seven lamellose varices and spines on the shoulder, spiral sculpture of four scabrous major cords, interstices scaly. Colour light brown.

India : Gujarat, Maharashtra, Goa. Arabian Sea.

Subfamily : DRUPINAE

Shell is small with a low acute spire, globosely ovate, sculptured with tubercles. Aperture is ovate and narrow, outer lip with either simple or compound teeth, columella with a single or double fold or with no folds.

The members are common in shallow coral reef habitats, abundant in Andaman and Nicobar Islands.

***Drupa (Drupa) lobata* (Blainville, 1832)**

(Pl. 55, fig. 5, 6)

Shell small, up to 31 mm in length, spire acute, low, body whorl large. Aperture narrow, elongate, not constricted, outer lip margin crenulated, with five digitate processes extending from the ridges, first one canaliculated, rest scaly, interior margin with six rounded teeth, columella with callous extending posteriorly, with plications on the anterior, often with open umbilicus. Sculptured with nodulose spiral ridges, and three to four scabrous rings in the interstices. Colour dark brown to chocolate, aperture white on the interior with dark chocolate brown margin.

India : Lakshadweep, Andaman and Nicobar Islands. Mauritius to Indonesia.

***Drupa (Drupa) morum morum* (Roeding, 1798)**

(Pl. 55, fig. 3)

Shell of medium size, up to 42 mm in length, globosely ovate, spire acuminate, low, body whorl large. Aperture long, narrow and constricted, outer lip with eight teeth arranged in fours, followed by two, a single tooth and the last one separated by a gap from others, inner lip with single axial fold bearing three plicae-like ridges, enameled callous, anal sulcus long and deep, siphonal canal short and deep. Body whorl with five rows of spinose tubercles, dark in colour, interstices with two rows of scabrous striations, outer lip margin with three rows of nodules that extend to small processes. Colour white with dark brown tubercles. Aperture deep violet on the interior.

India : Lakshadweep, Tamil Nadu: Gulf of Mannar; Andaman and Nicobar Islands, reef ecosystem. East Africa to Eastern Pacific.

Synonym : *Ricinula horrida* Lamarck, 1816.

***Drupa (Drupa) ricinus ricinus* (Linnaeus, 1753)**

(Pl. 55, fig. 11, 12)

Shell small, up to 26 mm in length, subovate, spire acute, low, body whorl large. Aperture long, narrow and constricted, outer lip with two sets of compound tooth arranged in fours and twos followed by two widely separated teeth, columella with a single fold bearing three to four oblique plicae-like ridges, callous with black dots towards posterior and anal sulcus long and deep, siphonal canal short, deep and open. Colour generally gray, aperture white and in majority with a continuous or broken orange yellow ring, tips of the spines dark brown.

India : Lakshadweep, Andaman and Nicobar Islands. Tropical Indo-Pacific.

The species occurs along with *D. (D.) morum morum*. It can be distinguished by long spinose tubercles, and by the presence of black dots on the columella and orange-yellow ring in the aperture.

***Drupa (Ricinella) rubusidæus* (Roeding, 1798)**

(Pl. 55, fig. 4)

Shell of medium size, up to 42 mm in length, ovately globose, spire acute and low, body whorl large. Aperture narrowly ovate, not constricted, anal sulcus deep and broad, outer lip margin with seven to nine teeth arranged in a row, inner lip broad, calloused, with three to four plications on the anterior end, siphonal canal short, deep and open. Body whorl with five rows of spinose tubercles, three to four rows of scabrous ridges in between the rows of tubercles. Tips of the tubercles dark brown and aperture interior light purple in colour.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific.

***Drupella cornus* (Roeding, 1798)**

(Pl. 55, fig. 8–10)

Shell of medium size, up to 37 mm in length, spindle shaped, spire acute and high with four whorls, suture impressed, body whorl large. Aperture narrowly ovate, anal sulcus deep, inverted U-shape, outer lip thick, margin crenulated, six to seven teeth on the interior, inner lip smooth, callose, two to three oblique plicae on the anterior end, canal short and open. Sculptured with four rows of prominent pointed tubercles on the body whorl, two rows on the penultimate whorl and a single row on the rest, spiral cords in between the rows of tubercles. Colour white, aperture white, often cream to light purplish interior.

India : Lakshadweep, Andaman and Nicobar Islands. Mauritius to Philippines.

***Drupella concatenata* (Lamarck, 1822)**

(Pl. 55, fig. 7)

Shell small, up to 31 mm in length, ovately elongate, spire acute and high, with five rounded whorls, body whorl large, suture impressed. Aperture narrowly ovate, outer lip thick with crenulated margin bearing six teeth on the interior, inner lip smooth with three plicae on the anterior end, canal short and open. Sculptured with four to five rows of rounded tubercles and two to three scabrous spiral ridges in between. Colour white, tubercles orange coloured, aperture white with cream or orange interior

India : Maharashtra: Bombay; Andaman and Nicobar Islands, reported to feed on corals. Mauritius to tropical Pacific, moderately common and widely distributed.

***Maculotriton serriale* (Deshayes in Laborde and Linant, 1834)**

(Pl. 56, fig. 1, 2)

Shell small, up to 15 mm in length, slender and elongate, spire high, with seven annulated whorls, body whorl large. Aperture narrowly elongate, outer lip thick and strong with a varix,

interior with six denticles, columella smooth, with two weak plications on the anterior end, canal short, narrow and deep. Sculptured with 12 to 15 axial ribs and 16 to 20 spiral cords becoming nodulose at intersections. Colour white, with two rows of chocolate brown markings on spire whorls and additional two rows on the body whorl.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar (Pamban); Andamans. Widely distributed in the Pacific but sparsely in the Indian Ocean.

Subfamily RAPANINAE

Shell is more or less pyriform, often produced anteriorly, spire short or depressed, inner lip smooth, canal short and broadly open.

Rapana rapiformis (Born, 1778)

(Pl. 56, fig. 3)

Shell large, up to 103 mm in length, pyriform, spire very low, with four to five whorls, suture deep and canaliculated, body whorl large and inflated. Aperture wide and oval, outer lip margin denticulate, interior lirate, inner lip smooth, wide and deep umbilicus, imbricately scaled fasciole, canal short and widely open. Sculptured with three low slightly nodulose spiral ridges, the row on the shoulder bear fifteen open, blunt hollow spines, the second and third row of spines on the middle and lower part of the body whorl decrease in size, several flattened spiral cords on the body whorl. Colour light brown with three to four chocolate brown bands on the body whorl, aperture light brown to cream.

India : Gujarat, Lakshadweep, Tamil Nadu, Andhra Pradesh, Orissa, occurs at moderate depths and caught in fishing nets. Indo-Pacific.

Synonym : *Rapana bulbosa* : Satyamurti, 1952.

Subfamily THAIDINAE

Shell is solid and heavy, spire moderately low, sculptured either with tubercles or knobs, aperture large, columella pustulose, outer lip either dentate or lirate, canal short.

This is another large subfamily after Muricinae and often treated as a family by some. The subfamily is represented by seven genera and 29 species in the Indian seas. These are common on the intertidal rocky coasts.

Cronia (Erglatax) contracta (Reeve, 1846)

(Pl. 56, fig. 4)

Shell of medium size, up to 37 mm in length, fusiform, spire elevated and acute, with six subangulated whorls, body whorl large. Aperture large, elongately ovate, outer lip finely

crenulated, with five to six denticles on the interior, inner lip smooth, with three to four plications on the anterior part, canal short, broadly open. Sculptured with eight to ten prominent axial ribs with one to two low rounded varices, and numerous fine, scabrous spiral threads. Colour chestnut brown to dark brown, aperture white to pinkish white.

India : East and West Coasts, Lakshadweep, Andaman and Nicobar Islands. Indo-West Pacific.

Synonym : *Drupa margariticola* of authors.

***Cronia konkanensis* (Melvill, 1893)**

(Pl. 56, fig. 6)

Shell small, up to 27 mm in length, pyramidally fusoid, spire high and acute, with five to six rounded whorls, body whorl large. Aperture elongately ovate, outer lip thick with crenulated margin and five teeth leading to raised lines on the interior, inner lip smooth with two to three plicae above short canal. Sculptured with axial ridges bearing six to seven rows of horizontal tubercles, and three spiral scabrous cords in between the rows of tubercles. Colour chocolate brown, tubercle and spiral cords white, aperture light violet with chocolate coloured margin.

India : Maharashtra: Bombay, Devgad; Tamil Nadu : Madras; Andaman and Nicobar Islands. Indian Ocean.

***Cronia ochrostoma* (Blainville, 1832)**

(Pl. 56, fig. 5)

Shell small, up to 21 mm in length, biconic shape, spire elevated, acute, consists of six subangulate whorls, suture wavy, body whorl gibbous. Aperture narrowly elongate, outer lip slightly crenulated and with six to seven denticles, inner lip smooth, three to four denticles on the posterior end, canal short. Sculptured with six to seven angulated axial ribs and prominent nodulose spiral cords and enclosing in between three to four scabrous threads. Colour white, aperture light orange.

India : Andamans. Tropical Indo-Pacific.

***Cronia subnodulosa* (Melvill, 1893)**

(Pl. 56, fig. 7)

Shell small, up to 24 mm in length, elongately fusoid, spire acute and high, with six angulated whorls, suture impressed. Aperture narrow and elongate, outer lip thick, with crenulated margin and five teeth on its interior, inner lip smooth with three to four faint plicae, canal short. Sculptured with eight to nine nodulose axial ribs, a single prominent row of nodules on spire whorls with

scabrous cords on either side. Colour chocolate brown, nodules dark brown, aperture light violet, margin dark brown with a prominent white band in the middle.

India : Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Andamans. Elsewhere : Pakistan (Karachi), Myanmar.

Thais bufo (Lamarck. 1822)

(Pl. 56, fig. 10)

Shell moderately large, up to 55 mm in length, solid, heavy and globose, spire acute, not much elevated, consists of three to four rounded whorls, body whorl large and slightly angulated. Aperture large, ovate, outer lip crenulated and with lirations on the interior, columella smooth, and with callous extending up to and even beyond the shoulder region, anal sulcus deep, siphonal canal short and broadly open. Sculptured with three to four rows of tubercles that become gradually obsolete towards the anterior end and with spiral cords. Aperture creamy white, outer lip margin chocolate brown, columella creamy yellow.

India : East and West Coasts, Andaman and Nicobar Islands, common on the rocky shores, not known from West Bengal coast. Indo-Pacific, not so common in the Pacific.

Shell bears some resemblance to that of *Purpura panama* that occupies the same habitat on intertidal rocks. In *M. bufo* the shell has a short spire, more globose body whorl and more prominent tubercles.

Reproductive system and breeding habits of *M. bufo* have received considerable attention (Chari, 1950; Rajalakshmi Bhanu *et al.*, 1982a,b,c). Sexes are separate and male possesses a wide dorso-ventrally flattened flagellate penis. Testis is connected to prostate gland by a straight, tube-like vas deferens. A straight tube leads from the prostate gland to penis. The secretions from the testis contain mucoproteins and glycolipids while those of prostate are rich in carbohydrates and variable amounts of protein.

Female reproductive system has two glands, namely albumen and capsular. Ovaries are connected to the albumen gland by oviduct, which opens into the gland at a point below the kidney. Albumen gland is creamish white and consists of several tubules lined by secretory cells. This gland opens into the ventral wall of capsular gland that is creamish yellow. The latter secretes the egg capsules that generally are deposited on the rocks in the intertidal region. Both the glands are highly proteinaceous. Secretions of albumen gland are rich in carbohydrates and protein and those of capsular gland contain mucoprotein. Albumen gland secretions are PAS positive and do not contain glycogen.

M. bufo has a peak breeding season from December to June at Visakhapatnam, Andhra Pradesh.

***Morula anaxares* (Kiener, 1836)**

(Pl. 56, fig. 11, 12)

Shell small, not more than 14 mm in length, spire short, acute and consists of four nodulose whorls, body whorl angulated and obtusely ovate. Aperture narrow and elongate, outer lip with crenulations on the margin and four rounded denticles on the interior, inner lip smooth, and with two to three plications on the anterior end. Sculptured with four spiral rows of nodules and striations, nodules larger on the first two rows giving angular appearance but they decrease in size on the other two rows. Colour dirty gray to light brown with white spiral bands, aperture light violet streaked with a white band, columella light violet, often with white markings.

India : Lakshadweep, Tamil Nadu: Gulf of Mannar; Andaman and Nicobar Islands. Indo-Pacific, with wider distribution in tropical Pacific.

***Morula biconica* (Blainville, 1832)**

(Pl. 57, fig. 6)

Shell small, up to 26 mm in length, spindle-shaped, spire acute and elevated, with five subangulated whorls, body whorl large and oblong. Aperture narrow and elongate, angulated, outer lip margin scabrous, interior denticulate, first two teeth large and compound, inner lip smooth with plications on the anterior end. Sculptured with eight to nine spinose axial ribs, and fine scabrous spiral cords, the one on the shoulder and middle of the body whorl prominent, broad and tuberculated. Colour white with brownish axial ribs and white spiral cords, aperture light violet.

India : East Coast, Andamans, not very common. Indo-Pacific, with wider distribution in the tropical Pacific.

***Morula granulata* (Duclos, 1832)**

(Pl. 56, fig. 8, 9)

Shell small, up to 30 mm in length, broadly spindle shaped, spire acute and elevated with four to five tuberculated whorls, body whorl large and angulated. Aperture narrowly ovate, outer lip thick, margin crenulated, interior with four teeth, inner lip smooth with two to three pustules above short and open canal. Sculptured with prominent spiral rows of tubercles, two on spire whorls and four on the body whorl with fine scabrous threads in between, tubercles more prominent near the shoulder. Colour dark gray to black, base of tubercles white, aperture violet, outer lip teeth bluish white, columella with a dark brown patch on its posterior end.

India : East and West Coasts, Lakshadweep, Andaman and Nicobar Islands, common on rocky shores. Tropical Indo-Pacific, common.

Synonym : *Drupa tuberculata* : Satyamurti, 1952 and other Indian records.

***Morula marginatra* (Blainville, 1832)**

(Pl. 57, fig. 8)

Shell small, up to 27 mm in length, pyramidally fusoid, spire acute and consists of four angulated whorls, suture distinct. Aperture narrowly ovate, outer lip margin thick and crenulated, interior with four prominent teeth leading to raised lines, inner lip smooth, but plicated in the middle, canal short and broad. Sculptured with longitudinal ribs broken to squarrose tubercles by the revolving scabrous cords, deep pits in the interstices, body whorl possesses four to five rows and each spire whorl with two rows of spiral cords. Colour grayish white with white horizontal lines on the centre of the body whorl, aperture light violet marked with dark chocolate brown lines inside, teeth white, outer lip margin chocolate brown.

India : Gujarat, Karnataka, Andaman and Nicobar Islands. Indo-West Pacific.

Shell bears some resemblance to those of *M. granulata* and young ones of *Thais hippocastanum*. It differs from the former in having deep pits in the interstices and a broader aperture and from the latter in the presence of deep pits and absence of spinose tubercles.

***Morula nodicostata* (Pease, 1868)**

(Pl. 57, fig. 2, 3)

Shell small, up to 21 mm in length, broadly ovate, spire high and consists of five subangulate whorls, suture obscure. Aperture narrowly ovate, outer lip margin thick, four to five denticles on the interior, inner lip smooth, with three light plicae on the anterior end, canal short. Sculptured with four to five rows of rounded nodules that decrease in size from anterior to the posterior, three to four scabrous spiral cords between the nodular rows. Colour light chocolate brown, nodules white, purplish brown spiral bands, aperture light violet with a broad white band on the interior, columella with a dark brown blotch on the posterior end.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Morula funiculata* (Reeve, 1846)**

(Pl. 57, fig. 7)

Shell small, not more than 10 mm in length, spindle shaped, spire elevated and consists of five whorls. Aperture narrow, elongately ovate, outer lip thick with a crenulated margin and five to six denticles on the interior, columella with three pustules above canal, anal sulcus deep, inverted U-shape bordered by a ridge. Sculptured with prominent nodulose spiral cords, two to three on spire whorls and six to seven on the body whorl. Colour white, with orange brown nodules, aperture white with brown markings on the columella.

India : Tamil Nadu: Gulf of Mannar (Tuticorin), not reported from any other locality. Elsewhere: Myanmar (Mergui Archipelago).

Morula uva (Roeding, 1798)

(Pl. 57, fig. 1, 5)

Shell small, up to 24 mm in length, more or less spindle shaped, spire elevated and consists of five to six whorls, body whorl large. Aperture narrow and elongate, constricted in the middle, outer lip margin thick and crenulated, with four to five denticles on the interior, upper two large and often combined, inner lip with three short plicae on the anterior end, ridge in the middle forming an angle, canal short. Sculptured with five rows of nodules on the body whorl and two rows on each of the spire whorl, nodules some times become spinose. Colour white, nodules dark brown or black, aperture light violet to purplish black with white denticles.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific, not common.

Shell bears some resemblance to that of the common species, *M. granulata*, but can be differentiated from it in the presence of spinose nodules and in having the first two denticles on the outer lip prominent.

Nassa sarta (Bruguere, 1789)

(Pl. 57, fig. 9)

Shell moderately large, up to 57 mm in length, oblong ovate, solid, spire short, consists of five slightly rounded whorls. Aperture oblong, outer lip margin finely crenulated, interior smooth, inner lip smooth with a denticle on the posterior end, a strong parietal ridge at the posterior end, canal short and broad, anal sulcus bordered by ridges, small fasciole. Colour chestnut brown with a transverse row of irregular blotches on the middle of the body whorl, aperture interior cream, outer lip margin and columella brownish.

India : Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands. Tropical Indo-Pacific, uncommon.

Purpura buccinea Deshayes, 1844

(Pl. 58, fig. 1)

Shell moderately large, up to 54 mm in length, oblong fusiform, spire high, consists of four to five rounded whorls. Aperture narrow, lineate, outer lip margin thick, finely crenulated, interior with eight to nine teeth leading to ridges, columella almost straight, smooth with an oblique fold in the middle forming an angle, plications on the anterior end. Sculptured with eight to nine broad axial ridges and seven to eight spiral cords on body whorl enclosing narrow cords in between. Aperture creamy white, outer lip margin dark chocolate brown, interior light brown, columella and shell surface chocolate brown.

India : Andaman and Nicobar Islands, not common. Elsewhere : New Guinea.

***Purpura panama* (Roeding, 1798)**

(Pl. 58, fig. 2)

Shell large, up to 77 mm in length, broad, spindle shaped, spire high and consists of three to four whorls, body whorl large and angulated. Aperture ovate, outer lip margin crenulated and do not lead to ridges, columella broad and obliquely grooved but not ridged as in the preceding species, siphonal canal short and broad. Sculptured with five broad spiral ridges and four to five narrow ridges in the interspaces, low-raised tubercles on the ridges. Colour chestnut brown with rows of white markings, aperture light orange, outer lip margin dark brown.

India : East and West Coasts, Lakshadweep, Andaman and Nicobar Islands, common in the mid-eulittoral zone. Elsewhere : Pakistan (Karachi), Sri Lanka, Philippines.

Synonyms : *Purpura rudolphi* Lamarck, 1822

Thais rudolphi (Lamarck, 1822)

***Purpura persica* (Linnaeus, 1758)**

(Pl. 58, fig. 3)

Shell large, up to 105 mm in length, oblong, spire low and consists of three whorls, body whorl inflated. Aperture wide, outer lip margin crenulated, interior with blunt teeth running as dark grooves, columella flattened, slightly twisted, grooved, calloused posteriorly. Sculptured with broad, obsolete knobbed, narrow spiral ridges. Colour grayish brown, ridges white with dark brown stripes, posterior part of columella with a dark brown blotch.

India : Gujarat : Porbandar; Andaman and Nicobar Islands, not common. Indo-West Pacific, moderately common in the Pacific.

***Thais armigera* (Link, 1807)**

(Pl. 59, fig. 1)

Shell large, up to 78 mm in length, spire high, acute and consists of five whorls. Aperture ovate, outer lip with seven to eight denticles, interior lirate, columella smooth, a little wrinkled with two to three denticles on the posterior part. Sculptured with two prominent rows of tubercles followed below by two rows of smaller tubercles. Colour brown, aperture with white interior and yellowish brown outer margin.

India : Lakshadweep, Andaman and Nicobar Islands. Tropical Indo-Pacific, not common.

***Thais blanfordi* (Melvill, 1893)**

(Pl. 59, fig. 2)

Shell small, up to 30 mm in length, ovately fusiform, spire high and acute, consists of four angulated whorls, body whorl large with a distinct angulation at the shoulder. Aperture ovate,

anal sulcus bordered by a ridge, outer lip with eight lirations arranged in pairs on the interior, inner lip smooth, slightly twisted on the anterior end. Sculptured with six and four major spiral threads above and below the shoulder respectively, axial sculpture consists of eleven to twelve low, sometimes inconspicuous tubercles. Colour generally light brown.

India : West Coast (common), Andamans. Arabian Sea to Singapore.

Shell bears some resemblance to that of *Thais tissoti* but differs in the absence of deep bisulcate transverse grooves and arrangement of denticles on the outer lip.

***Thais echinata* (Blainville, 1832)**

(Pl. 58, fig. 4)

Shell of medium size, up to 48 mm in length, ovate, spire a little high, consists of three to four tuberculated whorls. Aperture ovate, outer lip crenulated, with seven to eight teeth leading to ridges, inner lip bordered by a ridge. Sculptured with five rows of prominent blunt spines, scabrous spiral ridges. Colour light brown, aperture white with yellowish margin.

India : Gujarat : Veraval; Andhra Pradesh : Visakhapatnam; Andamans. Elsewhere : Sri Lanka to Philippines, not common.

Shell resembles that of *Mancinella alouina* but differs from it in the presence of prominent rows of spines on the body whorl and in the absence of reddish brown lirations inside the aperture.

***Thais hippocastanum* (Linnaeus, 1758)**

(Pl. 57, fig. 4)

Shell moderately large, up to 63 mm in length, spire high and consists of four angulated whorls. Aperture ovately narrow, outer lip crenulated with four to five prominent teeth on the interior leading to ridges, columella smooth, slightly folded anteriorly. Sculptured with four spiral rows of spines on the body whorl and four to seven spiral threads in between the rows of spines. Colour chocolate brown with vertical bands and dark brown spines, aperture bluish white and margin tinged with brown, denticles and ridges chocolate brown.

India : Lakshadweep, Maharashtra : Bombay; Andhra Pradesh : Visakhapatnam (common on intertidal rocks); Andaman and Nicobar Islands. Tropical Indo-Pacific.

***Thais intermedia* (Kiener, 1836)**

(Pl. 59, fig. 3)

Shell of medium size, up to 49 mm in length, spire elevated, with three whorls, slightly angulated, body whorl large and distinctly angulated, slightly depressed above the shoulder. Aperture ovate, outer lip thick, with a crenulated margin, and twelve teeth on the interior,

columella smooth, upper region with callous and with plications on the anterior end. Sculptured with four major spiral cords enclosing four to five minor cords in between. Tubercles dark brown interpolated with white bands, outer margin of outer lip chocolate brown with white blotches in between, columella with brown streaks and blotches at anal sulcus.

India : Lakshadweep, Tamil Nadu : Madras, Gulf of Mannar (Pamban); Andamans, not common. Tropical Indo-Pacific.

***Thais lacera* (Born, 1778)**

(Pl. 58, fig. 5)

Shell moderately large, up to 55 mm in length, ovate, spire acute, consists of four angulated whorls, body whorl strongly shouldered. Aperture large, ovate, outer lip finely crenulated, interior lirate, columella smooth, callose with partly closed umbilicus. Sculptured with flat and smooth, callouse, mildly scabrous transverse striations, two rows of tubercles on the upper part of the body whorl, sometimes developed into spines. Colour ashy brown, aperture light brown.

India : East and West Coasts, very common. East Africa to Japan.

This species is highly variable in size, sculpture and shape of the aperture. The snails live attached to jetties, rocks, boulders *etc.* in the river mouths and backwaters.

Synonyms : *Purpura carinifera* Lamarck, 1822

Cuma disjuncta Annandale, 1922

***Thais rugosa* (Born, 1778)**

(Pl. 59, fig. 5)

Shell of medium size, up to 42 mm in length, ovately fusiform, pagoda-like, spire high, consists of four angulated whorls, body whorl large, sloping above shoulder. Aperture moderately ovate, outer lip crenulated with grooved interior and with eight to nine denticles, columella smooth, with a small fold, anal sulcus broad and shallow, umbilicus wide and deep. Sculptured with four prominent ridges below shoulder, ornamented with compressed scales, interstices between the ridges with fine scabrous threads. Surface light brown, with scales and striations dark brown.

India : East and West Coasts, more common on West Coast, rocky substratum near low water mark. Indo-Pacific.

Synonyms : *Murex sacellum* Gmelin, 1791

Purpura sacellum Lamarck, 1822

***Thais tissoti* (Petit, 1852)**

(Pl. 58, fig. 6)

Shell small, up to 27 mm in length, spire elevated, body whorl large and oblong. Aperture narrowly ovate, outer lip margin and interior crenulated, columella smooth with plications on the anterior end, a ridge on the posterior end, umbilicus small and almost closed. Sculptured with four thick spiral ridges separated by bisulcate grooves, two narrow cords in between the first two ridges, ornamented with low tubercles. Colour light brown with dark brown tubercles.

India : Gujarat on West Coast to Andhra Pradesh on East Coast. Arabian Sea and Bay of Bengal.

It occurs along with *Thais blanfordi* on the rocks in the intertidal zone and bears some similarity to its shell. However, it can be distinguished from that species in possessing four strong spiral ridges and deep bisulcate grooves.

***Thais tuberosa* (Roeding, 1798)**

(Pl. 59, fig. 4)

Shell moderately large, up to 51 mm in length, oblong and heavy, spire elevated and consists of four spinose whorls. Aperture ovate, outer lip margin crenulated and its interior lirate, columella smooth, callouse with three to four light plications on the anterior end. Body whorl sculptured with three rows of thick blunt spines and broad scaly spiral cords in between those rows. Colour white with three to four black bands, aperture creamy white with three to four black blotches on the outer lip and two dark brown mottled areas on the columella and reddish brown lirae.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, reef ecosystem. Tropical Indo-Pacific, moderately common.

Shell looks somewhat similar to those of *Thais armigera* and *T. hippocastanum*. It differs from the former in having a shorter spire, in the absence of denticles on the outer lip, dark brown blotches on the aperture margin and reddish brown lirae. It can be differentiated from *T. hippocastanum*, by its shorter and blunt spire, by the absence of denticles on the outer lip and by the presence of more number of lirations in the aperture.

***Vexilla vexillum* (Gmelin, 1791)**

(Pl. 57, fig. 10)

Shell small, up to 24 mm in length, ovate, spire short and acute, consists of three rounded whorls, body whorl large and oblong. Aperture long and narrow, outer lip with thirteen denticles, columella smooth, calloused, twisted. Surface without any sculpture. Colour yellowish brown with dark brown spiral bands numbering two to three on spire whorls and eight on the body whorl.

India : Maharashtra : Bombay, not common. Indo-Pacific.

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Family CORALLIOPHILIDAE

False Tritons

Shell is small to large in size, usually not more than 100 mm in height, elongate and fusiform or globose. Whorls are few with a short spire. Aperture may be small and short or moderately wide, with a denticulate outer lip. Columella possesses a parietal callus, smooth or granulose. Siphonal canal is short to moderately long. Posterior canal is indistinct. Operculum, when present, is corneous with nucleus on the external margin.

Foot is short and reduced. Proboscis is pleurembolic with a distal buccal cavity. Radula is either reduced or absent since the snails feed upon corals suctorially. Alimentary system consists of a gland of Leiblein in the oesophageal region.

Sexes are separate. Males have a rudimentary penis that is blunt and rather dorso-ventrally flattened. Female stores the eggs in mantle cavity and releases veliger larvae.

These live in association with corals, either attached to the surface or as burrowers, in shallow tropical and subtropical seas. The family consists of about 200 species belonging to 6 genera. Three genera, namely *Coralliophila*, *Rapa* and *Latiaxis* are distributed in India, but the former two are dealt here.

Coralliophila abnormis E. A. Smith

(Pl. 59, fig. 14)

Shell small, up to 20 mm in height, solid but light, fusiform, spire about half the total length, protoconch 2 whorls, smooth. Whorls seven, rounded, sutures shallow. Aperture large, outer lip thin and margin crenulated, columella smooth, siphonal canal recurved and open, umbilicus absent. Sculptured with seven to eight axial varices and fine regular scaly spiral cords. Colour yellowish brown with dull white aperture.

India : Andamans. Indo-Pacific.

Coralliophila costularis (Lamarck, 1816)

(Pl. 59, fig. 13)

Shell small, up to 27 mm in height, thick and elongate, whorls rounded, body whorl more than half the total length of the shell. Aperture small, outer lip corrugated and liriate within, columella without callus shield, smooth and a parietal ridge, anterior canal long, narrow and recurved, posterior canal a sinus, umbilicus open, bordered by scaly ridge. Sculptured with strong, broad, varix-like axial ribs crossed by crowded, scaly, spiral cords. Colour off-white, aperture colour not clear since the collection is very old.

India : Andamans. Indian Ocean.

***Coralliophila erosa* (Roeding, 1798)**

(Pl. 59, fig. 6–9)

Shell of medium size, up to 32 mm in height, pointed at both ends, very much inflated in the middle giving a deformed-look, body whorl angulated at the centre, columella smooth, with callus at the lower half, umbilicus either open or closed, siphonal canal stunted and shallow. Sculptured with slightly broad axial ribs becoming obsolete near suture and crossed by numerous, close-set, scabrous spiral cords. Colour dirty white, aperture white.

India : Tamil Nadu : Gulf of Mannar; Andamans. Indo-Pacific.

Synonym : *Coralliophila deformis* (Lamarck, 1822)

***Coralliophila madreporara* (Sowerby, 1822)**

(Pl. 59, fig. 12)

Shell small, up to 22 mm in height, solid, ovate, spire low. Aperture flattened and large, outer lip flaring and smooth, columella shelf-like, siphonal canal absent, umbilicus absent. Sculptured with numerous close-set spiral threads and longitudinal striae. Colour white or gray, columella violet.

India : Andamans. Indo-Pacific, not common.

Synonym : *Quoyula madreporarum* (Sowerby, 1832)

***Coralliophila neritoidea* (Lamarck, 1816)**

(Pl. 59, fig. 10)

Shell small, up to 30 mm in height, thick, more or less fusiform, body whorl large and spire short, sutures shallow. Aperture large, about three-fourth length of the shell, outer lip slanting with sharp edge and finely dentate, and ridged within, columella with a callus-shield, a narrow umbilical channel, siphonal canal short and recurved. Sculptured with crowded, uneven, slightly scaly spiral lines. Colour off white, aperture rich violet. Surface generally encrusted.

India : Andamans.

Synonym : *Coralliophila violacea* (Kiener, 1836)

***Rapa rapa* (Linnaeus, 1758)**

(Pl. 59, fig. 11)

Shell large, up to 75 mm in height, thin, bulbous, with flat or slightly sunken spire and very expanded body whorl. Aperture moderately wide, constricted anteriorly, outer lip thin and crenulated by the ridges ending on it, columella with callus, which partly obscures the deep,

wide open umbilicus, strong fasciole, siphonal canal short and broadly open. Sculptured with rounded spiral ridges that increase in size and widely separated towards anterior end, fine spiral threads in between the ridges on the top and fine axial lamellae at the bottom. Colour uniformly cream.

India : Andamans. Indo-Pacific.

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Family BUCCINIDAE

Whelks

Shell is small to large in size, strong and thick, globose or ovate conical to fusiform. Protoconch consists of one or many whorls. Teleoconch consists of many whorls, with a fairly large body whorl and a somewhat tapering spire. Aperture is large and narrow to wide. Outer lip may be thickened and generally smooth often bearing plications on the inner margin. Columella is usually smooth, and sometimes thickened bearing a reflected callosity. A fasciole may be present at the base. Anterior canal is well developed, short to long and narrow to wide. Posterior canal is not distinct. Surface of the shell is smooth or sculptured with axial ribs and spiral cords or threads without strong varices. Operculum is ovate, thin, corneous brown with either apical or subcentral nucleus.

There are two cephalic tentacles bearing eyes at their outer bases. Foot is large, broad and anteriorly truncate. Siphon is well developed. Mantle cavity contains a monopectinate ctenidium, a bipectinate osphradium and often mucus secreting hypobranchial gland. Proboscis is strong, long and pleurembolic. Alimentary system consists of a stenoglossate radula (1-1-1 or 1-0-1) with multicuspid laterals, a pair of salivary glands with long ducts, well-developed oesophagus, stomach with caecum, and Leiblein and anal glands.

Sexes are separate. Male bears a broad, blunt and dorso-ventrally flattened penis. Female has a seminal receptacle. Eggs are laid in capsules and some eggs act as nurse cells. Development may be direct or indirect.

It is a very large cosmopolitan family divided into four subfamilies consisting of about 93 genera and about 300 species occurring from shallow intertidal areas to depths. These are carnivorous but are more scavengers than active predators. Indian fauna is represented by some well-known genera, such as *Babylonia*, *Phos*, *Cantharus* and *Engina*. A brackish water genus *Clea*, unique to Southeast Asia occurs in India.

Recent anatomical studies revealed that *Babylonia* has unique combination of characters such as accessory salivary gland, unusual anal gland, glandular dorsal folds in the mid-posterior oesophagus and a U-shaped stomach without a caecum. Hence it was concluded that *Babylonia* belongs to a separate family Babyloniidae (Harasewych and Kantor, 2000).

Subfamily BUCCININAE

Babylonia spirata (Linnaeus, 1758)

(Fig. 32, Pl. 60, fig. 1, 2)

Shell large, up to 70 mm in height, solid and heavy, ovate, body whorl inflated, spire high and elongate, sutures deep and channeled. Aperture large, ovate, outer lip sharp and smooth,

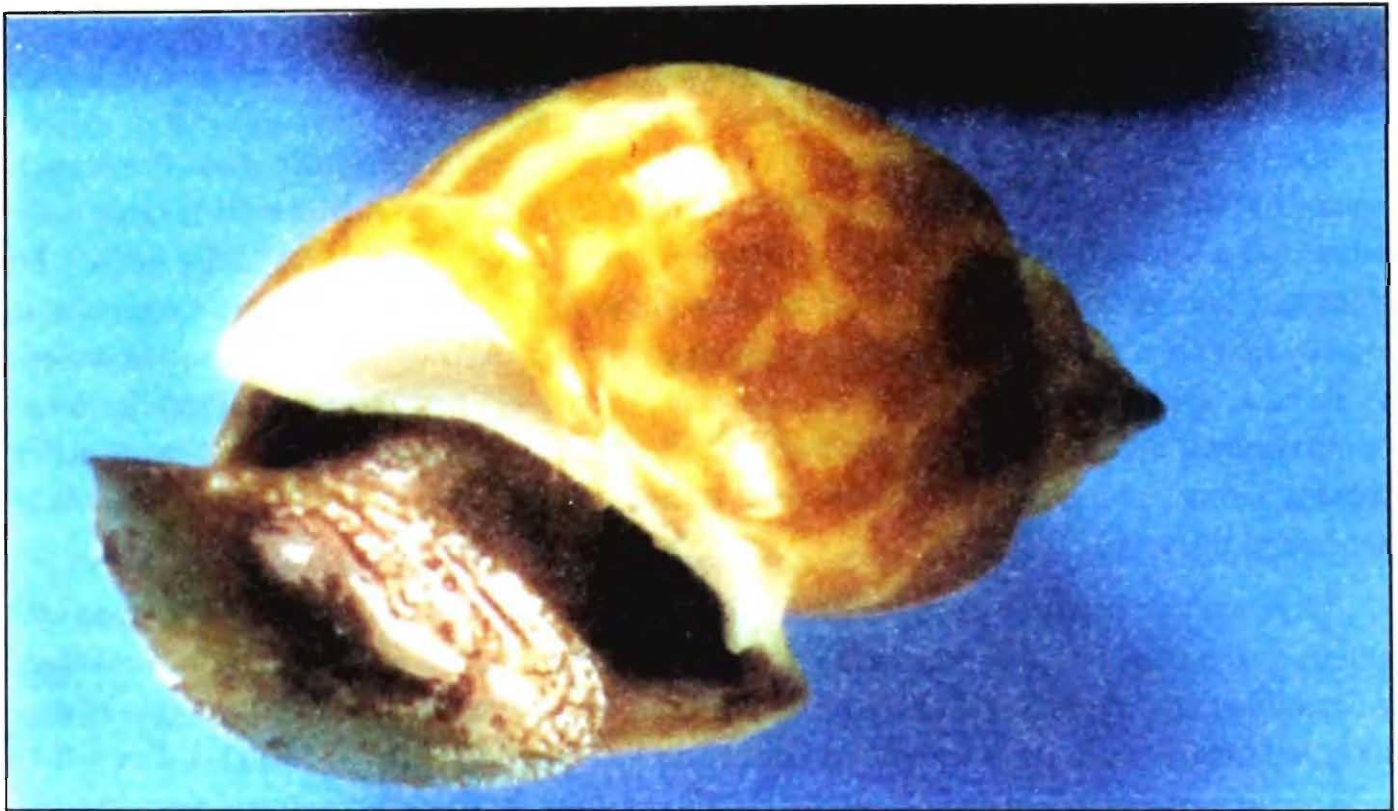


Fig. 32. *Babylonia spirata* with animal.



Fig. 33. *Babylonia zeylanica* with animal.

strongly flexed at top, columella smooth with heavy callus and a single thick ridge extending spirally inwards on the posterior side, umbilicus broad and deep, often obscured by the callus, a wide fasciole, anterior canal in the form of an oblique notch, posterior canal well developed, bordered by parietal callus. Surface smooth, white with prominent light brown blotches, oblique streaks and spots; aperture, outer lip and columellar callus white, fasciole orange brown, nuclear and post nuclear whorls purple.

India : Gujarat : Gulf of Kachchh (Beyt Island); Maharashtra : Bombay; Goa, Tamil Nadu, Andhra Pradesh : Visakhapatnam; Orissa, Andamans. Indian Ocean.

The record from Andamans is based on one old specimen labeled *Eburnea ambulacrum*. There are no recent collections and its occurrence in the islands is doubtful.

The species is exploited in good quantities from near Porto Novo (Tamil Nadu) and Sakthikulangara – Neendakara area (Kerala). The meat of it is exported to Japan (Appukuttan, 1996).

Synonyms : *Babylonia canaliculata* Schumacher, 1817

Eburnea ambulacrum Sowerby.

***Babylonia zeylanica* (Bruguere, 1789)**

(Fig. 33, Pl. 60, fig. 3)

Shell large, up to 70 mm in height, fusiform, less solid and with less inflated whorls, body whorl narrower than in *B. spirata*, sutures not canaliculated, spire high ending in dark purple apex. Aperture large, outer lip sharp and smooth, but not flexed at top, columella smooth, with heavy broad callus posteriorly but narrow anteriorly, a strong parietal ridge almost close to the outer lip, umbilicus broadly open with a row of teeth on the outer margin, fasciole with a ridge on the inner edge, anterior canal broad and deep, posterior canal not distinct. Surface smooth, colour white with large brown blotches.

India : Kerala : Tiruvananthapuram; Andhra Pradesh : Visakhapatnam; Pondicherry. Indian Ocean.

The species is caught as a by-catch in shrimp trawlers at Sakthikulangara–Neendakara area (Kerala). The meat of this species is also exported to Japan (Appukuttan, 1996).

***Clea bocki* Brot,**

(Pl. 61, fig. 8)

Shell small, not more than 20 mm in height, body whorl large, about three fourth of the total height of the shell, a total of six whorls, rounded, sutures shallow. Aperture large, almost half of

the total height, outer lip thickened, with lirations on the interior, columella with callous, smooth, anterior canal short, broad and shallow, umbilicus absent. Sculptured with axial and spiral ribs, colour grayish brown, aperture white.

India : Andhra Pradesh : Godavary Estuary near Narasapur.

Subfamily PHOTINAE

Phos senticosus (Linnaeus, 1758)

(Pl. 61, fig. 10)

Shell of medium size, up to 35 mm in height, pyramidal, spire highly elevated, whorls angulated at shoulder, suture impressed and constricted. Aperture moderately wide, outer lip a little bit thick, wavy, with strong lirations on the interior, columella calloused anteriorly and with two plications, a posterior parietal ridge, anterior canal slightly twisted, posterior canal insignificant. Surface sculptured with spiral ridges and axial ribs with nodules at intersections, spiral threads in between ridges. Colour pink brown, body whorl with a darker band on the middle, suture and aperture white.

India : Andamans, not common. Indo-Pacific.

Phos textum (Gmelin, 1791)

(Pl. 61, fig. 12, 13)

Shell small, up to 27 mm in height, spire not as much elevated as in *P. senticosus*, sutures not much impressed. Aperture moderately wide and lirate within, outer lip thick and with an indistinct notch anteriorly, columella with callus, with an indistinct fold on the lower columellar shield, anterior canal broad and short, posterior canal absent. Sculptured with sinuous and angulate oblique axial ribs crossed by spiral threads, the top spiral thread on each whorl bears spines at the junction with axial ribs. Uniformly cream coloured, aperture orange coloured, lirations dark brown, columella and outer lip blotched with dark brown at the posterior and anterior ends.

India : Andamans, not common. Indo-West Pacific, common in weedy coral sand.

Synonym : *Phos blainvillei* Deshayes, 1832

Nassaria acuminata (Reeve, 1844)

(Pl. 61, fig. 11)

Shell small, up to 23 mm in height, spire high with smooth protoconch of 2 to 3 whorls, body whorl slightly shorter than the spire, sutures distinct. Aperture small, with strong lirations

on the interior, outer lip thickened with a varix, finely denticulate on the margin, columella plicate, anterior canal shorter than in *N. pusilla* and obliquely recurved, posterior canal distinct bordered by ridges on either side. Sculptured with strong axial ribs and occasional varices, crossed by crowded spiral cords. Colour yellowish with white aperture.

India : Maharashtra : Bombay; Tamil Nadu : Madras; Pondicherry, Orissa : Ganjam, Puri. Indo-West Pacific, offshore.

Synonym : *Nassaria bitubercularis* (A. Adams, 1851)

Nassaria suturalis (A. Adams, 1853)

Nassaria coromandalica (E.A. Smith, 1894)

(Pl. 60, fig. 5)

Shell small, up to 30 mm in height, fusiform, spire high, with smooth and glossy protoconch of 2 whorls, body whorl half of the total height. Aperture narrow, with lirations on the interior, outer lip thickened occasionally with a varix, usually margin not crenulated as in other two species of the genus, columella with a strong parietal plication and two prominent plications on the anterior side, wrinkles on the rest, anterior canal broad but not strongly recurved, posterior canal distinct. Sculptured with narrow axial ribs crossed by spiral cords forming nodules at the cross sections, the surface more nodulose than in the other two species, the interspaces between the strong spiral cords with fine spiral thread. Colour half white or dull brown with white aperture.

India : Bay of Bengal. Elsewhere : Sri Lanka, 180 to 360 m, probably endemic to Bay of Bengal.

Nassaria pusilla (Roeding, 1798)

(Pl. 61, fig. 7)

Shell small, up to 20 mm in height, solid, spire elevated, protoconch smooth, 1½ whorl, body whorl of same height as the spire. Aperture small, with strong lirations on the interior, outer lip finely dentate, columella lirate, anterior canal slightly elongate. Strong axial ribs crossed by spiral cords forming nodules at inter sections. Colour uniformly creamish with white aperture.

India : Orissa : Ganjam, Puri; Andhra Pradesh : Visakhapatnam; Tamil Nadu : Tranquebar. South and Southeast Asia, offshore, 10 to 20 m.

Synonym : *Nassaria nivea* (Gmelin, 1791)

Subfamily PISANIINAE

Cantharus (Pollia) fumosus (Dillwyn, 1817)

(Pl. 61, fig. 5)

Shell small, up to 25 mm in height, thick, body whorl higher than the spire. Aperture large, half of the total shell height, outer lip thick and lirate within, columella with callus bearing irregular folds, umbilicus obscured by the callus, anterior canal short and broad, posterior canal with a fold. Sculptured with strong, broad and rounded axial ribs bisected by regular spiral ridges. Colour yellowish with dark brown ribs, with a spiral white band; aperture, columella and outer lip white.

India : Gujarat. Indian Ocean, not common.

Cantharus (Pollia) spiralis (Gray, 1846)

(Pl. 61, fig. 3)

Shell of medium size, up to 45 mm in height, thick with strongly shouldered whorls, spire narrow and shorter than the body whorl. Aperture broad, outer lip thick, wavy, and flexed at top, lirate within, columella with callus and smooth, a small depression on the outer edge of columella anteriorly. Sculptured with ten strong white spiral ribs separated by broad brownish grooves on the body whorl, three on the spire whorls, interspaces with spiral threads, the lowermost spiral rib broader and thicker bordering the depression. Colour brownish with white aperture.

India : Gujarat, Maharashtra, Tamil Nadu, Pondicherry. Indo-Pacific.

Cantharus (Pollia) tranquebaricus (Gmelin, 1791)

(Pl. 61, fig. 1, 2)

Shell of medium size, up to 40 mm in height, fusiform, thick, body whorl larger and higher than the spire, sutures well demarcated, whorls angulate at the shoulders. Aperture large, outer lip thick, flexed posteriorly, with distinct teeth continuing on to the interior ridges, columella with callus and irregular wrinkles, anterior canal broad and short, posterior canal absent, umbilicus absent but with a distinct fasciole. Surface sculptured with varix-like axial ridges, about nine on the body whorl, forming flattish knobs on the shoulder, crossed by spiral chords separated by shallow grooves, each chord formed by two or three fine spiral threads. A thick brown periostracum, colour yellowish, aperture white.

India : Tamil Nadu : Madras, Gulf of Mannar; Pondicherry (very common). Indian Ocean.

Cantharus (Pollia) undosus (Linnaeus, 1758)

(Pl. 61, fig. 4)

Shell of medium size, up to 40 mm in height, fusiform, heavy and solid, spire short and straight sided, sutures shallow. Aperture narrow, outer lip thick with a varix, ridged within,

columella smooth interiorly but irregularly plicate on the outer margin, fasciole weak, anterior canal short and broad, posterior canal bordered by a parietal tooth and labrum tooth. Sculptured with heavy and angular, evenly spaced spiral ribs. Colour pale yellow, with dark brown ribs separated by white or orange interspaces, aperture white, outer lip and lower half of columella stained with orange.

India : Gujarat, Maharashtra, Goa, Tamil Nadu, Andhra Pradesh : Visakhapatnam.

Cantharus (Pollia) wagneri (Anton, 1839)

(Pl. 61, fig. 6)

Shell small, up to 30 mm in height, thick and heavy, body whorl higher than the spire, constricted towards the base. Aperture narrow, outer lip thickened, with five to six strong teeth and the anterior-most forming a ledge entering the aperture, columella calloused, with lirations on the parietal wall and two prominent teeth on the lower half. Sculptured with broad axial ribs prominently crossed by sharply raised spiral cords. Colour creamy white, ornamented with orange brown bands or spiral rows of brown spots, aperture creamy white.

India : Andamans, not common. Indo-Pacific.

Synonym : *Turbinella crenulata* Reeve, 1847

Pisania ignea (Gmelin, 1791)

(Pl. 60, fig. 4)

Shell of medium size, up to 35 mm in height, narrow, thin, spire almost as high as the body whorl, apex usually eroded. Aperture moderately wide, outer lip thin, weakly fluted, occasionally with obsolete teeth in the posterior half and a distinct and strong denticle at the posterior end bordering the canal, columella smooth and flexed at the base with a denticle at the posterior end. Surface smooth except for the growth striae, weak spiral cords at the base of the body whorl. Colour yellowish with dark brown axial flames and blotches, aperture dull white.

India : Bay of Bengal, not common. Indo-Pacific.

Synonym : *Pisania buccinulum* Roeding, 1798

Engina alveolata (Kiener, 1836)

(Pl. 60, fig. 10, 11)

Shell small, up to 20 mm in height, pointed at both ends, body whorl longer than the spire, protoconch of one smooth whorl. Aperture narrow, outer lip thickened and denticulate, columella

calloused and denticulate, anterior canal short and narrow, posterior canal bordered by teeth on either side. Sculptured with nodulose axial ribs, strong spiral threads enclosing in the interstices fine spiral threads, a row of nodules at the suture. Colour grayish with brown nodules, encircled by a white band on the body whorl, columella and outer lip purple brown with white denticles.

India : Andamans. Indo- Pacific.

***Engina lineata* (Reeve, 1846)**

(Pl. 60, fig. 8)

Shell small, usually not more than 8 mm in height, ovate with acuminate spire, whorls 6. Aperture narrow, outer lip thickened bearing six teeth, columella calloused with plications throughout. Sculptured with broad axial ribs crossed by numerous spiral cords. Colour dull white ornamented with deep chocolate to black lines, extending to aperture and columella, spire whorl with a single spiral line and body whorl with one on upper part and double on lower part.

India : Lakshadweep, Tamil Nadu : Pamban. Mainly Pacific.

Synonym : *Engina trifasciata* Satyamurti, 1952.

***Engina mendicaria* (Linnaeus, 1758)**

(Pl. 60, fig. 9)

Shell small, up to 17 mm in length, solid, with a short spire and large body whorl, whorls roundly shouldered. Aperture narrow and higher than the spire, outer lip thickened, slightly varicose, with large coalescing teeth in the centre. Columella calloused, parietal wall plicate, central area of columella smooth and lower half bears a row of connected nodules. Sculptured with obsolete growth striae and spiral cords. Colour blackish with yellowish spiral bands, columella and denticles on outer lip purple brown.

India : Lakshadweep, Tamil Nadu, Andamans, common under rocks near the high tide line. Indo-Pacific.

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Family COLUMBELLIDAE

Dove Shells

Shell is small to medium, solid and fusiform. Whorls are many with a small to large body whorl and high acute spire. Aperture usually is long and narrow. Siphonal canal is very short. Outer lip is thin or thickened and often with denticulations on the interior margin. Columellar margin is smooth or weakly denticulated. Surface usually is smooth but sometimes with axial and spiral cords. Operculum, when present, is small, horny and oblong. Nucleus is either terminal or on the external border.

Cephalic tentacles are long and slender bearing eyes at their outer bases. Foot is large and narrow. Siphon is long and fleshy. Mantle cavity contains a hypobranchial gland. Proboscis is pleurembolic with a distal buccal cavity. Radula is rachiglossate (1-1-1 or 1-0-1). There is a posterior pyriform valve of Leiblein in the anterior oesophagus. A small gland of Leiblein is present.

Sexes are separate. Male has a large, tapering and tubular penis enclosed in a pouch. Eggs are laid in hemispherical capsules on hard substrata. Development is indirect.

Dove Shells occur in warm temperate and tropical seas from the intertidal zone to 200 m. The family is divided into two subfamilies namely Columbellinae and Pyreninae, which include about 50 genera and about 400 species. Six genera, namely *Pseudanachis*, *Columbella*, *Anachis*, *Euplica*, *Pyrene* and *Mitrella* occur in Indian Seas.

Subfamily COLUMBELLINAE

Pseudanachis duclosiana (Sowerby, 1847)

(Pl. 62, fig. 10, 11)

Shell small, up to 15 mm in height, ovate and acuminate, body whorl more than half the length of the shell. Aperture broad, flexuous, outer lip thickened with denticles on the interior, columella with denticles on the interior, canal short and acuminate. Sculptured with fine axial ribs, interstices finely striated. Colour dark brown.

Radula is rachiglossate. It is a long ribbon consisting of more than 108 transverse rows of teeth. Each transverse row has one central flanked by one lateral on either side. The central tooth bears 12 strong denticulations.

India : West Bengal, Orissa, Andhra Pradesh. Indo-Pacific.

It is gregarious and lives attached to undersurface of hard objects near low water mark.

Columbella turturina Lamarck, 1822

(Pl. 62, fig. 4, 5)

Shell small, up to 12 mm in height, solid, bulbous, inflated at the shoulder, apex pointed. Aperture very narrow, outer lip thickened, with eight to nine conspicuous denticles, columella with two rows of denticles, two large denticles on the inner side and five to six denticles on the outer side. Surface smooth except for spiral cords at the base of the body whorl. Colour white, ornamented with orange brown spiral lines, aperture pinkish.

India : Lakshadweep, Andaman and Nicobar Islands, not common. Indo-Pacific.

Subfamily PYRENINAE

Euplica varians (Sowerby, 1832)

(Pl. 62, fig. 12)

Shell small, up to 10 mm in height, solid, short spire. Aperture narrow, outer lip slightly thickened, with seven denticles, columella with two rows of teeth, one split tooth on the interior and six denticles on the outer margin. Sculptured with axial ribs on the spire whorls, axial nodes at the shoulder and prominent spiral cords at the base of the whorl. Colour whitish with spiral rows of reddish brown markings or lines, aperture light violet.

India : Lakshadweep, Tamil Nadu, coral reefs, moderately common. Indo-Pacific.

Mitrella blanda (Sowerby, 1844)

(Pl. 62, fig. 8, 9)

Shell small, up to 18 mm in height, elongate fusiform, protoconch of two whorls, pointed. Aperture narrow and elongate covering three-fourths of the body whorl, outer lip thickened with varix bearing obsolete lirations, columella arched and smooth without denticles, a narrow and short anterior canal, a posterior sinus. Surface very glossy and smooth except for obsolete spiral striae at base. Colour pale yellow with wavy, zigzag brown axial streaks, dorsum of body whorl near suture slightly elevated in the centre and with streaks of dark brown colour making the area distinct, aperture pale yellow.

India : Gujarat, common in clear sandy areas in river mouths or shallow bays. Not known from East Coast of India. Probably restricted to Arabian Sea.

Mitrella puella (Sowerby, 1844)

(Pl. 62, fig. 13a-d)

Shell small, up to 12 mm in height, protoconch of two whorls, teleoconch consists of eight flat-sided whorls, sutures distinctly prominent, body whorl almost half the total length of the

shell. Aperture narrow, outer lip thickened, varicose and with six denticles on the outer margin, anterior canal short and slightly recurved. Surface generally smooth, often with axial riblets on the early whorls, base of body whorl with strong spiral oblique cords. Colour whitish with irregular reddish-brown spots.

India : Andamans, very rare. Indo-West Pacific.

Synonym : *Columbella conspersa* Gaskoin, 1852

***Pyrene flava* (Bruguiere, 1789)**

(Pl. 62, fig. 6, 7)

Shell small, up to 25 mm in height, elongately spindle-shaped, whorls evenly rounded, devoid of angular shoulder, sutures slightly impressed. Aperture moderately broad rather narrowed posteriorly, outer lip slightly thickened and denticulated within, columella with a thin deposit of callus. Surface smooth, but body whorl sculptured with fine spiral ridges at the base. Colour deep yellow with a subsutural spiral row of a few widely spaced, large white spots, aperture and columella whitish.

India : Tamil Nadu : Gulf of Mannar (Pamban, Krusadai Island); Andamans.

Synonym : *Columbella flavida* Lamarck, 1822

***Pyrene philippinarum* Recluz, 1843**

(Pl. 62, fig. 1)

Shell small, up to 25 mm in height, thick and solid, broadly biconic, spire highly elevated and pointed, protoconch of two whorls, rounded at the shoulder. Aperture narrow and elongate almost reaching up to the shoulder of the body whorl, outer lip thick with incurved margin, with denticulations on the interior, columella straight, with thin callus and smooth interior. Surface smooth except for six to eight strong spiral ridges at the base. Colour cream, ornamented with reddish brown lines, a narrow white band in the centre.

India : Andamans. Indo-Pacific.

***Pyrene scripta* (Lamarck, 1822)**

(Pl. 62, fig. 2, 3)

Shell small, up to 15 mm in height, broadly spindle shaped with a moderately short spire, body whorl longer than the spire, whorls angularly shouldered below the suture. Aperture narrow and elongate, slightly flexed in the middle, outer lip thick, straight, the posterior end stands slightly out of the level of the spire due to the angulation of the body whorl, inner margin with about 10 to 12 strong denticulations, columella slightly arched, with thin callus, anterior half

with an axial row of granules and two small close-set teeth on the interior. Body whorl with fine close-set spiral grooves, weaker at the shoulder, obsolete above, but strong and conspicuous at the base. Colour white, ornamented with dark brown lines and dots arranged in transpiral lines below suture followed by a clear white zone, a series of irregular brown dots or spots below the white zone.

India : Gujarat : Gulf of Kachchh; Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, common near coral reefs. Indo-Pacific.

Synonym : *Pyrene versicolor* (Sowerby, 1832)

Pyrene testudinaria (Link, 1807)

(Pl. fig.)

Shell small, up to 20 mm in height, solid, pointed at both ends, but broader and more widely ovate than in *P. flava*, whorls evenly rounded, with a comparatively short spire. Aperture narrow, outer lip thickened and finely denticulate on the interior, columella slightly arched, with four to five denticles on the anterior end. Surface smooth except for spiral cords at the base of the body whorl. Colour white with bright, orange brown markings, numerous on the lower half but large and few on the upper half.

India : Tamil Nadu : Krusadai Island. Indo-Pacific.

Synonym : *Columbella vulpecula* Sowerby, 1847

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Family NASSARIIDAE

Mud Snails, Dog Whelks

Shell is small to medium in size ranging up to 40 mm in length. It is broad and ovately rounded to slender and narrowly elongate with numerous whorls and an elevated spire. Aperture is constricted, and rounded to narrow. Anterior canal is very short and usually fissured. Posterior canal usually is in the form of a notch. Outer lip is thick and either smooth or lirated on the interior. Columella is twisted and develops callus which in some grows into a broad shield often covering the entire ventral surface. Size of the columellar shield is variable and it depends on the developmental stage of the individual. Columella is either smooth or with denticles. Umbilicus is covered. Surface of the shell is sculptured with spiral and axial striae or ribs, often being obsolete on the last two whorls. Sometimes nodules may develop or there may be many rows of tiny granules or tubercles. Operculum is variable, small and of different shapes, irregularly ovate, subtrigonal or claw-like and rarely serrate.

Tentacles are moderately large bearing eyes at their outer bases. Foot is long and broad, rather narrow and pointed, some times bifurcated posteriorly. Siphon is long and conspicuous. Mantle cavity consists of a monopectinate ctenidium, bipectinate osphradium and hypobranchial gland. Proboscis is long and pleurembolic with a terminal buccal cavity. Radula is stenoglossate (1-1-1). Alimentary system consists of a small gland of Leiblein in the oesophagus and a crystalline style in the stomach.

Sexes are separate. Male has a tubular penis and a prostate gland. In the female there is an accessory oviductal opening in the mantle cavity, a bursa copulatrix, capsule gland, seminal receptacle, ingesting gland and gonopericardial duct. Eggs are laid in capsules. Veliger has a long duration of life.

The family has representatives in brackish water and from shallow intertidal region to depths of the sea. The snails prefer soft substrata like mud or sand. A few are herbivores but majority are carnivores or scavengers feeding on carrion. Mud snails can be seen clustering around a dead animal.

The family is divided into three subfamilies which include a total of 12 genera and about 200 species.

Subfamily DORSANIINAE

Bullia (Bullia) melanoides (Deshayes, 1832)

(Pl. 63, fig. 3)

Shell small, up to 20 mm in length, solid, narrowly elongate with slender spire, whorls slightly inflated, sutures well defined, protoconch of about three smooth whorls. Aperture small

with a widely open notch of the anterior canal, outer lip thin. Surface distinctly latticed due to the intersection of axial ribs and fine spiral grooves, middle of the body whorl smooth, its base generally with four to five strong spiral grooves, a single groove immediately below the sutures and below it two close-set grooves. Colour dark purplish gray with a whitish or pale brown glossy apex.

India : Gujarat : Somnath; Karnataka : Mangalore; Kerala : Quilon; Tamil Nadu : Tiruchendur, Kilakkarai, Kundugal Point, Krusadai Is., Pamban, Dhanushkodi, Rameswaram; restricted to sandy shores of India.

***Bullia (Bullia) tranquebarica* (Roeding, 1798)**

(Pl. 63, fig. 2)

Shell moderately large, up to 35 mm in length, elongate ovate, light weight, body whorl half the total shell length. Aperture wide, outer lip smooth, callus smooth, anterior canal short, broad and fissured. Sculptured with irregular spiral grooves and a subsutural ridge, spiral grooves more prominent at the base of the body whorl. Colour yellowish to pale brown often with dark brown wavy axial streaks, aperture white.

India : Maharashtra : Bombay; Lakshadweep; Tamil Nadu : Madras, Tranquebar, Karaikkal, Nagapattinam; Andhra Pradesh : Visakhapatnam; Orissa : Puri, sandy shores along east and west coasts. Indian Ocean.

It differs from *B. melanoides* in the absence of latticed sculpture and in having a wider aperture.

***Bullia (Dorsanum) vittata* (Linnaeus, 1767)**

(Fig. 34, Pl. 63, fig. 1)

Shell moderately large, up to 55 mm in length, elongately turreted, protoconch of three smooth whorls. Aperture wide, outer lip thin, columella smooth, anterior siphonal notch very wide. Sculptured with spiral grooves separated by wide interspaces, three rows of beaded spiral cords just below the sutures. Colour livid brown.

India : Orissa : Gopalpur, Puri, Konark, Chilka mouth; Andhra Pradesh : Bheemunipatnam, Visakhapatnam; Tamil Nadu : Madras, Agasthiampalli, Tranquebar; Pondicherry, Andamans, common on the sandy shores of east coast. Indian Ocean.

It is mainly a species of continental shores where it prefers surf beaten intertidal zone. It has a massive foot with the help of which it quickly burrows into the sand.

Synonym : *Bullia livida* (Reeve, 1846).



Fig. 34. *Bullia vittata* with animal.

Subfamily NASSARIINAE

Nassarius (Nassarius) coronatus (Bruguiere, 1789)

(Pl. 63, fig. 4, 5)

Shell of medium size, up to 34 mm in length, broadly ovate, thick, body whorl longer than the spire, protoconch of two whorls, smooth. Aperture broad, outer lip thick with lirations on the interior, posteriorly notched columella with a callus shield but smaller than in *N. arcularius*, a basal fold and a parietal ridge, anterior canal broad and truncated. Sculptured with strong axial ribs crossed by spiral grooves on spire whorls; body whorl with blunt coronations on the shoulder and spiral grooves on the basal part. Coloured brown or greenish brown, dark brown between coronations, a white subsutural line, aperture purplish brown to white.

India : Andaman and Nicobar Islands. Indo-West Pacific.

Nassarius (Hima) stolatus (Gmelin, 1791)

(Pl. 65, fig. 8)

Shell small, up to 15 mm in height, ovately conical with inflated body whorl, pointed spire, whorls overlapping at the suture. Aperture ovate with a small apical notch, outer lip thickened, backed by a varix, extending above up to half of the penultimate whorl, with six to seven denticles on the interior, columella calloused with five to six denticles and laminations anteriorly. Sculptured with axial ribs, almost obsolete on the dorsal side of body whorl and in the form of nodules below suture, spiral grooves prominent at the base of the body whorl. Colour yellowish-white with three broad chestnut spiral bands also seen through the aperture.

India : Maharashtra : Bombay; Tamil Nadu : Madras, Tuticorin, Agasthiampalli, Adirampattinam, Tranquebar, Pamban; Pondicherry, West Bengal : Sunderbans, common. Indo-West Pacific.

Nassarius subconstrictus (Sowerby, 1899)

(Pl. 65, fig. 6, 7)

Shell small, up to 12 mm in height, fusiform, whorls 7–8, regularly increasing, suture impressed with a constriction below. Aperture obliquely ovate, siphonal canal short, broad and a little recurved, columella excavated, porcellaneous, with a well-defined restricted callus, thickened to form a tubercle at the posterior end and outer lip coarsely and varicosely thickened posteriorly, with fine denticles on the inner margin. Sculptured with characteristic coarse, longitudinal ribs on the spire whorls and on the shoulder of the body whorl, which become obsolete below, base with fine, wavy spiral striae. Colour greenish when fresh, becoming pale greenish yellow on preservation, ornamented with subsutural and broad basal bands, interior of aperture white, columella margin white and tinged with flesh red.

India : Tamil Nadu : Ennur backwaters; Orissa : Chilka Lake (from many localities); West Bengal : Port Canning (Type locality).

Synonym : *Nassa denegabilis* Preston, 1914 (Type locality : Chilka Lake).

Nassarius (Niotha) albescens gemmuliferus (A. Adams, 1852)

(Pl. 63, fig. 6, 7)

Shell small, up to 15 mm in height, elongate ovate, spire pointed, protoconch of three whorls, smooth, body whorl longer than the spire. Aperture small, outer lip thickened and lirate interiorly, columella calloused, with three to six denticles on the lower half and a parietal denticle above, anterior canal narrow and posterior sinus short. Sculptured with oblique granulated axial ribs crossed by spiral grooves, nodules just below sutures large and more distinct. Colour creamy

white, some with one or two dark brown spiral bands on the body whorl, apex creamy white, aperture white.

India : Andamans, Indian Seas. Indian Ocean.

***Nassarius (Niotha) conoidalis* (Deshayes in Belanger, 1832)**

Shell small, up to 20 mm in height, body whorl stubby and expanded, sutures broad or narrow and channeled. Aperture wide, outer lip lirate on the interior with 8 to 10 denticles, columella with expanded callus covering the body whorl, wrinkled or granulose, anterior canal deep and recurved. Sculptured with regular granules arranged in close-set axial and spiral rows, four or five on penultimate whorl, 8 to 10 on the body whorl. Colour fleshy brown, occasionally with two faint bands on the body whorl, columella cream, aperture interior with two purplish brown bands.

India : Karnataka : Mangalore; Tamil Nadu : Madras, Tranquebar; Pondicherry (common); Orissa : Puri, Chatrapur; Andamans. Indo-Pacific.

Occurs on coral and weedy sands from shallow intertidal to deeper water and also on mudflats.

Synonyms : *Buccinum gemmulatum* Lamarck, 1822 is a primary homonym of *Buccinum gemmulatum* Wood, 1818

***Nassarius (Niotha) distortus* (A. Adams, 1852)**

(Pl. 63, fig. 8)

Shell small, up to 25 mm in height. Aperture moderately broad and round, outer lip slightly thickened, with 12 to 17 lirations on the interior, columella with slightly expanded callus, columellar margin smooth except for a parietal denticle and two to four small denticles at the base, anterior canal short and deep, posterior canal narrow. Sculptured with axial ribs separated by broad, smooth spaces, 12 to 16 ribs on the penultimate whorl and 12 to 17 on the body whorl, ribs stepped up at sutures and separated from the subsutural nodules, coarse spiral cords at the base of the body whorl. Colour cream or half-white, ornamented with a brown band at the centre of the body whorl, apex purple, aperture interior light brown with a dark band, columella and outer lip white.

India : Tamil Nadu. Indo-Pacific.

***Nassarius (Niotha) jacksonianus* (Quoy & Gaimard, 1833)**

(Pl. 64, fig. 2)

Shell small, up to 15 mm in length, ovately conical, spire acute and longer than the aperture. Outer lip with a varix externally and with four to six elongated denticles on the interior, columellar callus strongly laminated on the body whorl, with four to six denticles anteriorly. Sculptured

with widely spaced axial ribs, 12 to 13 on the penultimate whorl, six to eight on the body whorl, on the latter 12 to 15 overriding spiral cords, obsolete on the dorsum, remains of nodules just below the suture, colour cream with brown spiral bands, outer lip white, aperture white with a purplish band inside.

India : Maharashtra : Bombay; Tamil Nadu : Madras, Tuticorin, Porto Novo, Mandapam, Pamban, Krusadai Is., Kundugal Point; Pondicherry, Orissa : Puri, Chilka Lake; Indian Ocean.

It bears some resemblance to *Nassarius stolatus* (Gmelin).

Nassarius (Niotha) livescens (Philippi, 1840)

(Pl. 64, fig. 1)

Shell small, up to 20 mm in length, gemmulate or noded. Outer lip with 10 to 13 lirations on the interior, columella with a strong callus extending on to the body whorl, often the callus thin above parietal wall and form thick lamina in that region, 4 to 10 denticles on the inner margin, anal canal short and deep. Sculptured with oblique axial ribs and crossed by deeply incised or shallow spiral grooves forming granules at the intersections, subsutural row of granules more conspicuous than the rest. Colour creamy-white with two to three broad brown bands on the body whorl, in some clouded with brown, columellar callus and outer lip white.

India : Maharashtra : Bombay; Lakshadweep, Tamil Nadu, Orissa, Andaman and Nicobar Islands. Indo-Pacific, occurs in weedy intertidal sands.

Nassarius (Niotha) luridus (Gould, 1849)

(Pl. 64, fig. 5, 6)

Shell small, up to 25 mm in height, elongate ovate, with inflated body whorl, spire pointed. Aperture moderately large, outer lip with lirations on the interior, columella with thick callus but not much expanded, columellar margin with obsolete denticles, strong parietal lamina and an anterior lamina, anterior canal deep, posterior canal broadly open. Sculptured with close-set axial ribs on the early whorls, others smooth with nodules just below the suture, seven to eight strong spiral striae at the base of the body whorl, the back of the outer lip often with four to six crowded axial ribs. Colour variable white-gray, ornamented with orange-brown lines, with dark brown spots near the sutures, aperture with purple-brown interior.

India : Andamans.

Nassarius (Niotha) nodiferus (Powys, 1835)

(Pl. 64, fig. 4)

Shell small, up to 25 mm in height, with convex whorls, body whorl inflated. Aperture broadly oval, outer lip with 10 to 11 denticles, thickened axial ribs on the back, columella

calloused forming shield on the body whorl, columellar margin with irregular denticles, anterior and posterior canals broad, the latter bordered by parietal ridge, with a fasciole. Sculptured with widely spaced coarse axial ribs, 13 to 18 on the spire whorls, 22 on the body whorl, ribs constricted a little below suture forming nodules, strong spiral cords at the base of the body whorl. Colour brown, ornamented with pale and narrow spiral bands, columella, outer lip white, aperture purple-brown with band.

India : Maharashtra : Bombay; Tamil Nadu : Tuticorin, Tranquebar, Rameswaram; Andamans. Indo-Pacific.

***Nassarius (Plicarcularia) globosus* (Quoy & Gaimard, 1833)**

(Pl. 64, fig. 9, 10)

Shell small, up to 20 mm in height, spire pointed. Aperture narrowly elongate, columella with large, smooth and rounded callus, with two or three denticles at the base and a parietal ridge, outer lip thickened, with lirations on the interior, anterior canal broad and deep, posterior canal distinct bordered by a parietal ridge. Sculptured with beaded axial ribs and spiral rows of granules all over. Colour fawn or brown, occasionally with a broad, dark brown band on the body whorl, columellar callus white or cream.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Nassarius (Plicarcularia) graniferus* (Kiener, 1834)**

(Pl. 64, fig. 7, 8)

Shell small, up to 25 mm in height, spire pointed. Aperture narrow, columellar callus expanded covering the body whorl on the ventral side, nodulose on the upper part, with one or two denticles at the base, upper lip thickened, with 10 to 12 denticles at the base, lirations on the interior, anterior canal deep and short, posterior canal distinct. Sculptured with rows of evenly spaced nodules, one row on the early whorls, two on the penultimate whorl and four on the body whorl, with axial growth striae and spiral striae. Colour cream to fawn, columellar callus white, aperture with yellow interior.

India : Andamans. Indo-Pacific.

***Nassarius (Plicarcularia) pullus* (Linnaeus, 1758)**

(Pl. 65, fig. 1, 2)

Shell small, up to 20 mm in height, solid, body whorl longer than the spire. Aperture small, outer lip strongly thickened and lirated on the interior, columellar callus large covering totally the ventral part of the body whorl, with three or four denticles, a strong fold at the base, a thick

parietal ridge bordering the short deep posterior canal, anterior canal short, deep and forked. Sculptured with a humped callosity on the dorsum, early whorls ribbed, slender axial ribs throughout except on the left of the dorsal hump, two to four granulose spiral cords on the base of the body whorl, incised line below the suture. Colour olive or brown with a narrow white line on the body whorl in some, columellar callus creamy white.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu : Gulf of Mannar, Tranquebar; Pondicherry, Andamans, not common. Indo-West Pacific.

Synonyms : *Nassarius thersites* (Bruguiere, 1789)

Nassarius gracilis (Pease, 1868)

Nassarius (Zeuxis) dorsatus (Roeding, 1798)

(Pl. fig.)

Shell large, up to 90 mm in height, solid and elongate. Aperture large, outer lip thickened supported by a prominent varix, with weak lirations on the interior and three to eight weak denticles on the margin, columella calloused and finely denticulate. Sculptured with axial ribs and sutural nodules on the apical whorls, body whorl smooth with 8 to 10 oblique cords at the base. Colour variable, steel gray with obsolete brown bands, occasionally tan or dark brown, interior of aperture purple brown.

India : Tamil Nadu : Madras, Tuticorin, Porto Novo, Tranquebar, Rameswaram, Palk Bay; Pondicherry, common. Indo-West Pacific.

Synonym : *Nassarius canaliculatum* (Lamarck, 1822)

Nassarius (Zeuxis) foveolatus (Reeve, 1853)

(Pl. 65, fig. 5)

Shell small, up to 20 mm in height, oblong ovate, spire elevated and acute, body whorl narrower than in other species. Aperture ovate, outer lip slanting supported by a varix, 12 to 14 lirations on the interior, anteriorly with five to seven small projecting spines, columella with not much expanded callus, margin with denticles all along, the posterior most and the anterior most stronger and drawn into the aperture, parietal denticle strong bordering the narrow anal canal, anterior canal broad and deep. Sculptured with close-set, fine axial ribs on all the whorls, interstices with spiral striae giving cancellate appearance, with a subsutural ridge. Colour yellow or yellowish brown, aperture cream.

India : Maharashtra : Bombay; Kerala, Tamil Nadu : Madras, Porto Novo; Orissa : Chilka Lake; West Bengal : Digha, Sunderbans; common. Indian Ocean.

***Nassarius (Zeuxis) olivaceus* (Bruguiere, 1798)**

(Pl. 65, fig. 3)

Shell of medium size, up to 40 mm in height, thick, body whorl longer than the spire. Aperture small, outer lip thickened and slanting, with varix behind and denticles on the inner edge, columella concave and calloused, with denticles, anterior canal well-developed and shallow, anal canal short and bordered by a parietal ridge. Sculptured with oblique axial ribs on the early whorls, later smooth, body whorl smooth with spiral grooves at the base, conspicuous on the ventral side and towards the varix of the outer lip. Colour tan to dark brown, often with yellow band at the shoulder of the body whorl, interior of aperture purple-brown.

India : Tamil Nadu: Rameswaram; Pondicherry, Andamans, not common. Indo-Pacific.

***Hebra horridus* (Dunker, 1847)**

(Pl. 65, fig. 4)

Shell small, up to 15 mm in length, elongate ovate with pointed spire. Aperture rounded, outer lip thickened with lirations on the interior, columellar callus wide spreading over to the body whorl, margin with about six denticles, callus surface with granules and wrinkles. Sculptured with spinose axial ribs crossed by spiral threads. Colour light brown often with dark brownish bands.

India : Andamans. Indo-Pacific.

Synonyms : *Nassarius curta* (Gould, 1850)

Nassarius muricata (Quoy and Gaimard, 1833)

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Family MELONGENIDAE

Crown Conchs, Whelks

Shell is medium to large and thick having a pyriform to fusiform shape. Whorls are a few with a more or less flattened or elevated spire bearing a sizable protoconch. Shell is covered by brown or opaque periostracum. Aperture is large and wide with a thickened and smooth outer lip. Columella is also smooth and without any plaits. Sculpture is not very conspicuous. There may be a few spiral cords at the base and strong knobs or tubercles at the shoulder. Operculum is thick, horny and unguiculate with a terminal nucleus.

Head bears a pair of tentacles. Foot is large and powerful. Mantle cavity contains a large monopectinate ctenidium, bipectinate osphradium and large hypobranchial gland. Proboscis is long, narrow tipped and pleurembolic with a distal buccal cavity. Radula is stenoglossate (1-1-1) or rarely it may be absent. Alimentary system consists of a pair of large salivary glands without accessory glands and a gland of Leiblein in some. Melongenids do not have accessory boring organ and accessory salivary glands unlike muricids. Some malacologists are in favour of including melongenids in the family Buccinidae due to similarity in their radular and anatomical characteristics.

Sexes are separate. Male has a large penis on the right side and the female has a large capsule gland. The eggs are laid in clusters or strings. There is a free-swimming larval stage but frequently a crawling young may emerge out of the egg.

Melongenids feed on gastropods, bivalves, polychaetes, ascidians and carrion. Recent laboratory studies had shown that *P. cochlidium* feeds on bivalves such as *Anadara granosa*, *Perna viridis*, *Meretrix costa*, *Meretrix meretrix* and *Katelysia opima* (= *Marcia opima*) and unidentified polychaetes (Benny *et al.*, 1996; Siraimetan *et al.*, 1988). Studies on other melongenids also revealed that they feed on bivalves. However, the feeding habits of a species may vary from place to place. In Singapore *P. cochlidium* was observed to feed on the barnacle *Balanus amphitrite* and *Balanus variegates* (Tan and Phauah, 1999).

These are mainly carnivores or scavengers, occurring on muddy sand substrates in shallow water, where clams are also available. It is a small family with six genera and about 30 species. The genus *Pugilina* is common in the Indian ocean. In India the genus is represented by three species, which occur in bays and backwaters.

Pugilina (Hemifusus) carnarium (Roeding, 1798)

(Pl. 66, fig. 1, 2)

Shell large, up to 110 mm in height, solid and heavy, body whorl wide with a short and blunt spire. Aperture very wide, outer lip thick and smooth. Columella with callus from anterior to posterior end, smooth, umbilicus open. Sculptured with one row of small tubercles just near the suture on spire whorls, two rows of strong tubercles on the body whorl, one at the

shoulder being larger than the one below it, spiral cords on the spire whorls and on the body whorl below the lower row of tubercles. Colour wheatish-brown, with a thick periostracum, aperture white.

India : Gujarat, not known from the East Coast. Indian ocean.

Synonym : *Melongena bucephala* Lamarck, 1822.

***Pugilina (Hemifusus) cochlidium* (Linnaeus, 1758)**

(Pl. 66, fig. 3, 4)

Shell large, up to 105 mm in height, almost pear shaped, solid and heavy, whorls angular, concave from suture to shoulder, shell less broad than in *P. carnarium*. Aperture narrow and elongate, outer lip with obsolete ridges, columella without any fold, anterior canal short and broadly open, very narrow and shallow umbilicus, strong fasciole. Sculptured with axial ribs on the spire whorls, body whorl with close set spiral ridges on the lower half and more or less smooth on the remaining part, a row of about eight strong compressed tubercles at the angular shoulder of the last two whorls. Colour reddish brown, interior of aperture brownish yellow.

India : East and West Coasts, common in the shallow muddy areas and estuaries, abundant in the Kakinada Bay, Andhra Pradesh. Indian Ocean.

***Pugilina (Hemifusus) ternatanus* (Gmelin, 1791)**

(Pl. 66, fig. 5, 6)

Shell large, up to 100 mm in height, lightweight, ovately pyriform, whorls angular at shoulder. Aperture broad and oval, outer lip thin, with lirations on the interior, columella with callus often with spiral ridges extending on to it, siphonal canal broad and long. Sculptured with irregular, obtuse spiral ridges, fine above the angle and broad below, prominently noduled at the angle. Colour fawn yellow to yellowish red, aperture flesh coloured.

India : Tamil Nadu, not common. Southeast Asia.

***Volema paradisiaca nodosa* (Lamarck, 1822)**

(Pl. 66, fig. 7, 8)

Shell of moderate size, up to 55 mm in height, thick, solid, ovately pyriform, spire short and blunt, body whorl slightly angulated at the shoulder. Aperture broad, outer lip thick with strong lirations on the interior, columella with thick callus on the anterior two thirds and thin callus on the posterior one third, umbilicus narrow, with a strong fasciole, anterior canal short and widely open, posterior canal distinct. Sculpture not as conspicuous as in the other species of the family,

small nodules on the spire whorls, often strong at the shoulder of the body whorl, ridges separated by distinct grooves at the base of the body whorl. Colour yellowish brown, sometimes with chocolate brown spiral bands. Colour yellowish brown, interior of aperture light brown.

India : No specific locality, rare. Indian Ocean.

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Family FASCIOLARIIDAE**Horse Conchs, Tulips**

Shell is small to very large, often attaining 200 mm in height (elsewhere it is 600 mm), fusiform or spindle-shaped with a few whorls and an elongate spire. It usually is covered by brown to opaque periostracum and usually not brightly coloured. Aperture is ovate to subpyriform with lirations on the interior. Outer lip may bear strong or weak denticles or smooth. Columella usually is smooth, but often may bear weak folds and a fasciole at the anterior end. Anterior siphonal canal is well developed and very long. Posterior sinus is indistinct. Shell surface may have axial and spiral cords, which may be strong and in some there are knobs on the body whorl. Operculum is brown, horny, fairly thick, oval to unguiculate with a terminal nucleus.

Head is small and narrow bearing short tentacles with eyes at their outer bases. Foot is broad and short. A monopectinate ctenidium, bipectinate osphradium and a hypobranchial gland are present in the mantle cavity. Proboscis is very long, pleurembolic with a distal buccal cavity. Radula is stenoglossate (1-1-1). Alimentary system, besides the usual structures, consists of large salivary glands, a small gland of Leiblein.

Sexes are separate. Male has a large penis. In female, the ingesting gland serves the function of seminal receptacle. Eggs are deposited in capsules and the development may be direct or through a free-swimming larva.

The family has a cosmopolitan distribution. Majority are deep-water forms while a few occur in shallow intertidal zone.

These are carnivores feeding on worms and clams.

The family is divided into four subfamilies, Fasciolarinae, Fusiniinae, Peristerniinae and Colubrariinae, which include about 32 genera and 200 species. Six genera and 20 species are reported from India. The subfamily Colubrariinae is elevated to a separate family by some (Boss, 1982).

Subfamily FASCIOLARIINAE***Pleuroploca filamentosa* (Roeding, 1798)**

(Pl. 67, fig. 1)

Shell large, up to 115 mm in height, solid, spindle shaped, suture adpressed, shoulders round, spire strongly elongate. Aperture elongate with close-set yellowish spiral ridges within, outer lip with dark brown denticles, columella with callus anteriorly, glazed, arched and with three to four plaits anteriorly, anterior canal elongate and slightly twisted. Surface sculptured with

prominent spiral cords crossed by faint axial striae, a row of axial nodules on each whorl. Colour bluish-white, cords reddish brown.

India : Lakshadweep, Tamil Nadu : Pamban, Krusadai Island, Shingle Island, Kilakkarai; Pondicherry. Indo-Pacific.

***Pleuroploca trapezium* (Linnaeus, 1758)**

(Pl. 67, fig. 2)

Shell very large, up to 170 mm in height, heavy and thick, spire strongly elevated and sharply pointed, shoulder strongly developed. Aperture broad, with strong ridges on the interior, outer lip with seven pairs of teeth where spiral lines meet the edge, columella with callus, smooth except for three anterior plaits, anterior canal broad and extended, fasciole weak. Sculptured with a little pointed strong knobs on the shoulders, incised paired spiral lines also seen through the aperture. Flesh coloured with incised dark brown lines, covered by dark periostracum, columella pale brown.

India : Tamil Nadu : Tuticorin, Pamban; Andamans. Indo-Pacific, moderately common under coral rocks in shallow water down to 20 m.

It is collected in large quantities on the Southeast coast of India and its meat is exported to Southeast Asia. About 225.2 tons in 1992 and 402.5 tons in 1993 were collected (Ayyakkannu, 1994).

Subfamily FUSININAE

***Fusinus colus* (Linnaeus, 1758)**

(Pl. 67, fig. 5)

Shell very large, up to 140 mm in height, spindle shaped with an elevated spire. Aperture moderately narrow and lirate within, outer lip finely dentate, columella with thin callus, without plaits or plications, ridges showing through, siphonal canal very long and slender. Sculptured with prominent axial ribs on early whorls, last three whorls with obsolete axial ribs remaining as two nodules on the shoulder, with prominent spiral ribs extending on to the siphonal canal. Usually white or light cream with a few brown streaks, brown between ribs and nodules, aperture white, edge tinged with brown.

India : Orissa : Chandipur, Chatrapur, Gopalpur; Tamil Nadu : Madras, Tuticorin, Pamban; Andamans. Indo-Pacific, occurs on sandy bottoms at 15 to 20 m depth.

The species of *Fusinus* are distinguished from that of *Fasciolaria* by their more slender and usually white shells, long, narrow and straight siphonal canal, in the absence of plaits on the columella and in their sculpture.

Synonyms : *Fusinus toreuma* (Deshayes, 1843)

Fusinus toreuma (Lamarck, 1822) : Satyamurti, 1952

Latirus andamanicus E. A. Smith, 1894.

***Fusinus forceps* (Perry, 1811)**

(Pl. 67, fig. 3)

Shell very large, up to 135 mm in height, solid, spindle shaped, spire whorls well rounded. Aperture oval, columella smooth with callus raising slightly above the level of the shell, with one or two weak parietal plications, outer lip thick with wavy outer margin and lirations on the interior, anterior canal long and slender, posterior sinus present. Sculptured with broad, rounded axial ribs crossed by fine spiral ridges which continue on to the siphonal canal. Colour white covered by pale brown periostracum.

India : Tamil Nadu : Gulf of Mannar. South Asia.

Synonym : *Fusinus turriculus* (Kiener, 1840)

***Fusinus nicobaricus* (Roeding, 1798)**

(Pl. 67, fig. 4)

Shell of medium size, up to 42 mm in length, smallest for the genus, elongately, fusiform. Aperture narrow and lirate, outer lip thin and smooth, columella with narrow callus, with plications on the margin, siphonal canal long and stout. Sculptured with axial ribs on early whorls, last two whorls with prominent nodes at the shoulder which tend to be duplicated by small nodes flanking to it, body whorl with very thick spiral cords and longitudinal striae prominent at suture. Colour cream with irregular reddish-brown longitudinal lines and streaks, aperture white.

India : Tamil Nadu : Tuticorin; Andaman and Nicobar Islands. Indo-Pacific.

It is distinguished by its more elevated and rounded spiral ridges and the dark coloured flames on the surface.

Subfamily PERISTERNIINAE

***Peristernia nassatula* Lamarck,**

(Pl. 67, fig. 7)

Shell small, up to 20 mm in height, solid, ovately oblong. Aperture narrow, with lirations on the interior, outer lip angulate with fine denticulations on the margin, columella with callus, two to three anterior plicae and a parietal plicae, anterior canal short and oblique. Sculptured

with strong axial ribs becoming nodulose at the shoulder on the last two whorls, rest of the surface with conspicuous spiral cords and axial striae. Colour light yellowish brown, reddish brown in the interstices between the ribs, often with dark orange brown band, aperture violet.

India : Andamans, rare. Indo-West pacific.

***Peristernia pulchella* (Reeve, 1847)**

(Pl. 68, fig. 3)

Shell small, up to 20 mm in height, narrowly fusiform, narrower than in *P. ustulata*. Aperture small and oval, lirate within, outer lip convex and thin, columella smooth with thin, narrow callus and anterior canal moderately long, but longer than in *P. ustulata*, posterior sinus present. Sculptured with strong, coarse and oblique axial ribs crossed by widely separated strong spiral cords. Colour yellowish-brown, aperture light brown.

India : Andamans, rare. Indo-Pacific.

***Peristernia ustulata* (Reeve, 1847)**

(Pl. 67, fig. 8, 9)

Shell small, up to 15 mm in height, thick. Aperture small and lirate within, outer lip convex, wavy and constricted basally, columella with callus and with three plicae anteriorly, anterior canal short and a little recurved. Sculptured with coarse axial ribs and scabrous spiral cords. Colour light yellowish brown, aperture cream coloured.

India : Andamans, rare. Indo-Pacific, common.

***Peristernia violacea* (Reeve, 1847)**

(Pl. 67, fig. 6)

Shell small, up to 20 mm in height, somewhat fusiform, spire high with acuminate apex. Aperture small and ovate, with seven to nine lirations on the interior, outer lip thin and wavy, columella with callus, smooth except for four plicae anteriorly, umbilicus narrowly open, anterior canal short and narrow. Sculptured with strong axial ribs, crossed by strong spiral cords. Colour dull white, aperture pinkish-violet when fresh, blackish-chestnut stain at base.

India : Andamans. Indo-Pacific.

***Latirus belcheri* (Reeve, 1847)**

(Pl. 68, fig. 1)

Shell of medium size, up to 35 mm in height, fusiform, spire rather turreted. Outer lip angulate and with denticles in fully grown specimens, constricted at the anterior end, columella with

callus anteriorly, three strong plicae anteriorly and one small denticle posteriorly, anterior canal open and moderately short. Sculptured with strong spiral cords enclosing in between fine striae, whorls concave round the upper part, encircled with a row of wavy nodes at the suture and a duplicate series of tubercles on the body whorl. Colour white, ornamented with conspicuous black flames and blotches and white axial lines, aperture light blue, denticles on outer lip blackish-brown.

India : Lakshadweep, rare. Indo-Pacific.

***Latirus craticulatus* (Linnaeus, 1758)**

(Pl. 68, fig. 2)

Shell of medium size, up to 45 mm in height, cylindrically elongated, thick, whorls convex. Aperture short and narrowly oval, outer lip convex, with lirations on the interior, constricted at the base, columella with four plicae anteriorly and a parietal denticle bordering the posterior sinus, anterior canal short and recurved to the left. Sculptured with obscure, blunt axial ribs, becoming obsolete on the lower part of the body whorl, sutures of the spire very finely scaled, spirally encircled with rather distantly placed prominent spiral cords. Colour yellowish-white, axial rib brick red, aperture dull white.

India : Andamans. Indo-Pacific.

The species can easily be demarcated by the coloured ribs.

***Latirus gibbulus* (Gmelin, 1791)**

(Pl. 68, fig. 5, 6)

Shell moderately large, up to 70 mm in height, fusiform, thick, solid, smooth. Whorls concavely depressed round the upper part. Aperture short, outer lip convex, constricted anteriorly with fine denticles on the margin, columella smooth, umbilicus large. Sculptured with obtuse rounded knobs at the angles, obsolete spiral threads and growth striae. Colour wheatish brown, with dark brown, paired spiral lines, aperture yellowish.

India : Lakshadweep, Andamans, not common. Indo-Pacific.

***Latirus nodatus* (Gmelin, 1791)**

(Pl. 68, fig. 3)

Shell small, up to 30 mm in height, solid. Aperture narrow, columella with 6 small plicae, siphonal canal moderate. Sculptured with large, coarse nodes and distinct spiral cords on the anterior end.

India : Andamans. Indo-Pacific.

Latirus polygonus (Gmelin, 1791)

(Pl. 68, fig. 7)

Shell moderately large, up to 60 mm in height, fusiform, angulate, sutures constricted. Outer lip finely denticulate and ridged within in fully grown specimens, columella with callus and four small plicae anteriorly, anterior canal broad and short with a weak fasciole. Whorls concavely depressed round the upper part, sculptured with strong spiral ridges, one row of blunt tubercles on the spire whorls, two rows on the body whorl. Colour cream and covered by a brown periostracum, dark brown spiral bands, aperture white.

India : Tamil Nadu: pearl banks off Tuticorin; Andamans. Indo-Pacific.

Leucozonia (Laterolagena) smaragdulus (Linnaeus, 1758)

(Pl. 68, fig. 9)

Shell of medium size, up to 35 mm in height, solid and globose. Aperture narrow, with obsolete lirations on the interior, outer lip thick and constricted anteriorly, columella with callus, with two to four plicae anteriorly and a parietal knob posteriorly, anterior canal short and oblique. Sculptured with close-set raised spiral cords separated by narrow grooves. Colour dark brown, spiral cords reddish-brown and interstices white, aperture white with a blackish stain on the anterior part of columella. In majority the outer lip is broken, so also the specimen figured.

India : Lakshadweep, Nicobars : Car Nicobar; common in the coral reefs. So far not reported from reefs of Gulf of Mannar. Indo-Pacific.

Subfamily COLUBRARIINAE

Colubraria muricata (Lightfoot, 1776)

(Pl. 68, fig. 8)

Shell large, up to 90 mm in height, solid, fusiform, whorls coiling irregularly, sutures shallow, protoconch of two whorls, smooth. Aperture narrow and elongate, outer lip thick, with twelve lirations on the interior, columella calloused, glazed and completely smooth, siphonal canal short, broad and a little recurved, posterior canal distinct and bordered by a parietal ridge. Sculptured with granulose axial ridges crossed by widely spaced spiral cords and two varices on each whorls. Colour creamish yellow, mottled and spotted dark brown, aperture white.

India : Andamans, rare. Indian Ocean.

Colubraria tortuosa (Reeve, 1844)

(Pl. 68, fig. 4)

Shell of medium size, up to 45 mm in height, thin, fusiform, whorls coiling irregularly, sutures shallow, protoconch of 1 ½ smooth whorls. Aperture narrow, outer lip slightly thickened, weakly lirate, columella with callus and without teeth, siphonal canal short and narrow, posterior canal absent. Sculptured with axial ribs crossed by spiral grooves producing beaded appearance, one varix on each whorl. Colour grayish brown and mottled with dark brown spots, aperture creamy white.

India : Andamans, rare. Indian Ocean.

Family VOLUTIDAE

Volutes, Bailer Shells.

Shell is moderate to very large in size, often extending up to 500 mm in height. It may be narrow with a high spire or inflated and globose with a sunken spire. Aperture is long and narrow to broadly open. Columella bears folds or plications as in mitres, but the anterior most fold usually is the strongest. Anterior canal is truncate and the posterior one is indistinct or absent. Surface is ornamented with shades of dark brown or orange. Operculum is absent in the majority.

Head is small and has a broad hood over the rhynchostome. Tentacles are short and eyes are sessile when present. Foot is large and broad. Mantle is large and often extends over the shell covering it partly. Its edge bears a siphon, which carries two processes or lappets. Mantle cavity consists of a monopectinate ctenidium, bipectinate osphradium, and a hypobranchial gland, which sometimes secretes purple fluid. Proboscis is pleurembolic, and short with a hood-cover. Radula rarely is stenoglossate (1-1-1) but usually is uniserrate with only a central (0-1-0). Alimentary system consists of tubular salivary glands and their accessory glands, and a gland of Leiblein in the oesophagus.

Sexes are separate. Male carries a penis, an open pallial gonoduct or a prostate gland. Eggs are laid in capsules and the development may be direct or through pelagic veliger larva.

It is a large family divided into nine subfamilies that include a total of about 46 genera and 250 species. These are widely distributed in shallow intertidal areas to deep waters of the sea. Majority however, occur in the offshore regions. They feed on molluscs or flesh of dead animals. These are poorly known in India and are represented by only four species.

Subfamily CYMBIINAE

Melo melo (Solander, 1786)

(Pl. 70, fig. 4, 5)

Shell very large, up to 200 mm in height, ovoid, not very thick, with reduced spire, enlarged and strongly inflated body whorl. Aperture very wide and elongated, columella with three to four folds, anterior canal broad and deeply excavated. Surface smooth except for oblique axial growth striae. Colour bright yellowish orange and ornamented with a few dark brown patches around the middle of the body whorl.

India : Tamil Nadu : Mostly off Coromandal Coast. Southeast India, Bangladesh to South China Sea through Malaysia, up to 10 m.

Although not common, shells are traded at Kanya Kumari and other coastal places of Tamil Nadu and also at Port Blair, Andamans. In the Port Blair market it is popularly known as Mango Shell. There is a good demand for this in local shellcraft industry. All shells are obtained from Tamil Nadu.

Synonym : *Cymbium indica* (Gmelin, 1791)

Subfamily ZIDONINAE

Harpulina lapponica (Linnaeus, 1767)

(Pl. 69, fig. 8)

Shell small, up to 20 mm in height, solid, ovate, spire more elevated than in *M. melo*, globose, protoconch of three smooth whorls, suture uneven and faintly channeled. Aperture narrow, outer lip thickened and slanting, columella with equally strong plaits anteriorly, four or five weak plications posteriorly, anterior canal narrow, posterior canal narrow and deep, callus partly covers fasciole. Sculptured with low axial ribs on spire whorls, obsolete on antepenultimate whorl, about ten low, axially pinched nodules on body whorl, becoming obsolete near the outer lip. Colour cream, ornamented with spiral rows of dark brown dots and dashes except for a band below suture, often with three spiral bands of pale brown blotches.

India : Tamil Nadu : Gulf of Mannar, coral reefs. Elsewhere : North Sri Lanka. Endemic to Bay of Bengal.

REFERENCE

Weaver, C. S. and du Pont, J. E. 1979. Living Volutes: A Monograph of the Recent Volutidae of the world. Delaware Museum of Natural History, *Monogr. Ser.* No. 1 : 1-375, 79 color pls.

Family : VASIDAE

Vase Shells, Chanks

Shell usually is large and heavy, with pyriform or fusiform shape. Body whorl is very large compared to the spire. Aperture is oval to narrowly lirated. Outer lip is thick and may be smooth or with a few teeth. Columella margin bears four to five strong folds. Anterior siphonal canal is long or short and the posterior canal is indistinct. Sculpture consists of rows of tubercles or nodes and distinct spiral cords. Operculum is corneous, oval and unguiculate with a terminal nucleus.

Head is small. Tentacles are also small bearing eyes at their outer bases. Foot is broad and may be bifid anteriorly. Proboscis is long and pleurembolic, with a distal buccal cavity. Radula is stenoglossate (1-1-1). Alimentary system consists of a small gland of Leiblein and its pyriform valve. Sexes are separate. Male has a penis that often bears a terminal process. Female lays eggs in strings of capsules.

They are common in the reefs of Gulf of Kachchh, Lakshadweep, Gulf of Mannar and Andaman and Nicobar Islands. They are carnivores and feed on worms and clams. The family is small containing about 25 species, occurring in shallow coral reefs. It is recognized into three subfamilies Vasinæ, Turbinellinae and Ptychatractinae. The first two have their representation in India.

Subfamily VASINAE

Vasum ceramicum Linnaeus, 1758

(Pl. 70, fig. 1)

Shell larger than in *V. turbinellus*, up to 100 mm in height, fusiform, solid and heavy, spire high, sutures indistinct. Aperture narrow and elongate. Outer lip thick, with four to five notches and four strong teeth, columella with callus and three strong ridges in the centre, anterior canal short, deep and wide, posterior canal a notch, with a fasciole. Sculptured with spiral rows of stout spines, one row on the lowermost spire whorl and penultimate whorl, body whorl with four rows, upper most row of spines stronger than the rest, spiral cords all over. Colour white, usually with encrustations not revealing the base colour, maculated with brown, columella white with brown blotches, outer lip white with brown teeth.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, intertidal zone of reef ecosystem. Indo-Pacific.

***Vasum turbinellus* Linnaeus, 1758**

(Pl. 70, fig. 3)

Shell smaller than in *V. ceramicum*, up to 85 mm in height, solid and heavy, spire moderate to short, sutures indistinct. Aperture narrow and elongate, outer lip with coarse, blunt teeth, columella with callus and three to four slightly oblique ridges, siphonal canal open and short, posterior notch indistinct. Sculptured with rows of spines, the upper most row on the shoulder with larger spines, followed below by a row of small blunt spines, then a rough ridge and then two rows of smaller, blunt spines on the base, and finally the fasciole ridge, surface generally malleate. Colour white with dark brown maculations, aperture white, teeth dark brown, columella cream, tinged with brown on the edge.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Andaman and Nicobar Islands, intertidal zone of reef ecosystem. Indo-Pacific.

***Tudicla spirillus* (Linnaeus, 1751)**

(Fig. 36, Pl. 69, fig. 9, 10)

Shell moderately large, up to 75 mm in height, pyriform, ventricose, body whorl bulbous with flatly depressed spire and knob-like protoconch. Columella with broadly expanded, projecting, plate-like callus, aperture interior grooved, anterior canal narrow and long as in muricids, recurved anteriorly. Sculpture consists of faint transverse grooves, with a sharp ridge and compressed nodules at the angulated shoulder and a row of solitary nodules above the shoulder. Colour brownish gray with irregularly placed reddish-brown blotches especially above the ridge, dark reddish-brown dashes on the ridge, aperture and columella white.

India : Tamil Nadu, Pondicherry, off shore, common. Endemic to Bay of Bengal from Southeast India to Sri Lanka.

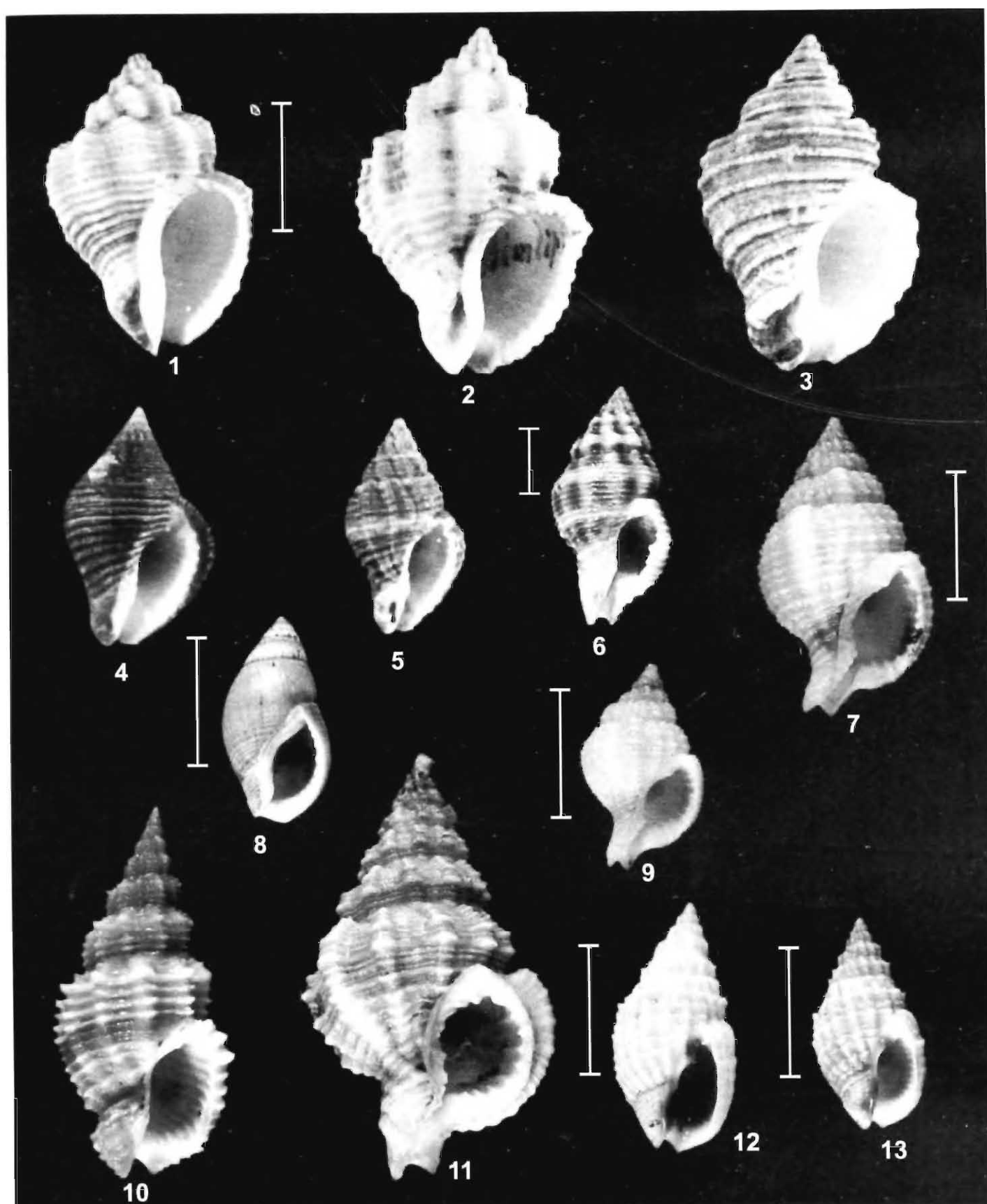
Subfamily TURBINELLINAE***Turbinella pyrum* (Linnaeus, 1758)**

(Fig. 35, Pl. 69, fig. 1-7)

There are three kinds of chanks, namely the sacred chank of India, the Caribbean chank and the Brazilian chank, each belonging to a separate species under the genus *Turbinella*.

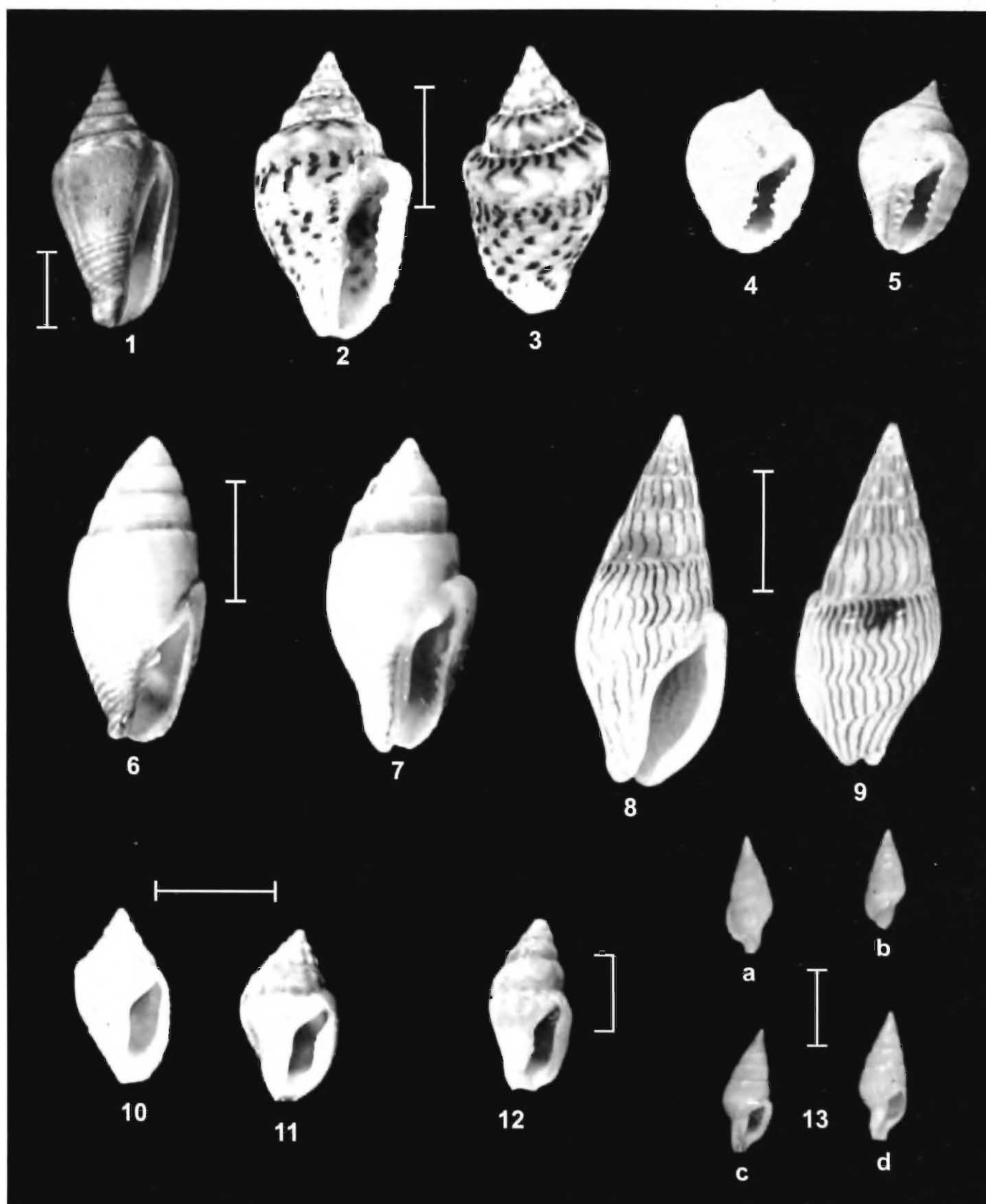
The Indian chank has a strong and spindle shaped shell measuring up to 140 mm in height. Its external surface is covered with a velvety brown periostracum. The aperture is wide with a long and deep anterior canal. There are three to four strong columellar ridges, which give support

Plate 61 : Buccinidae



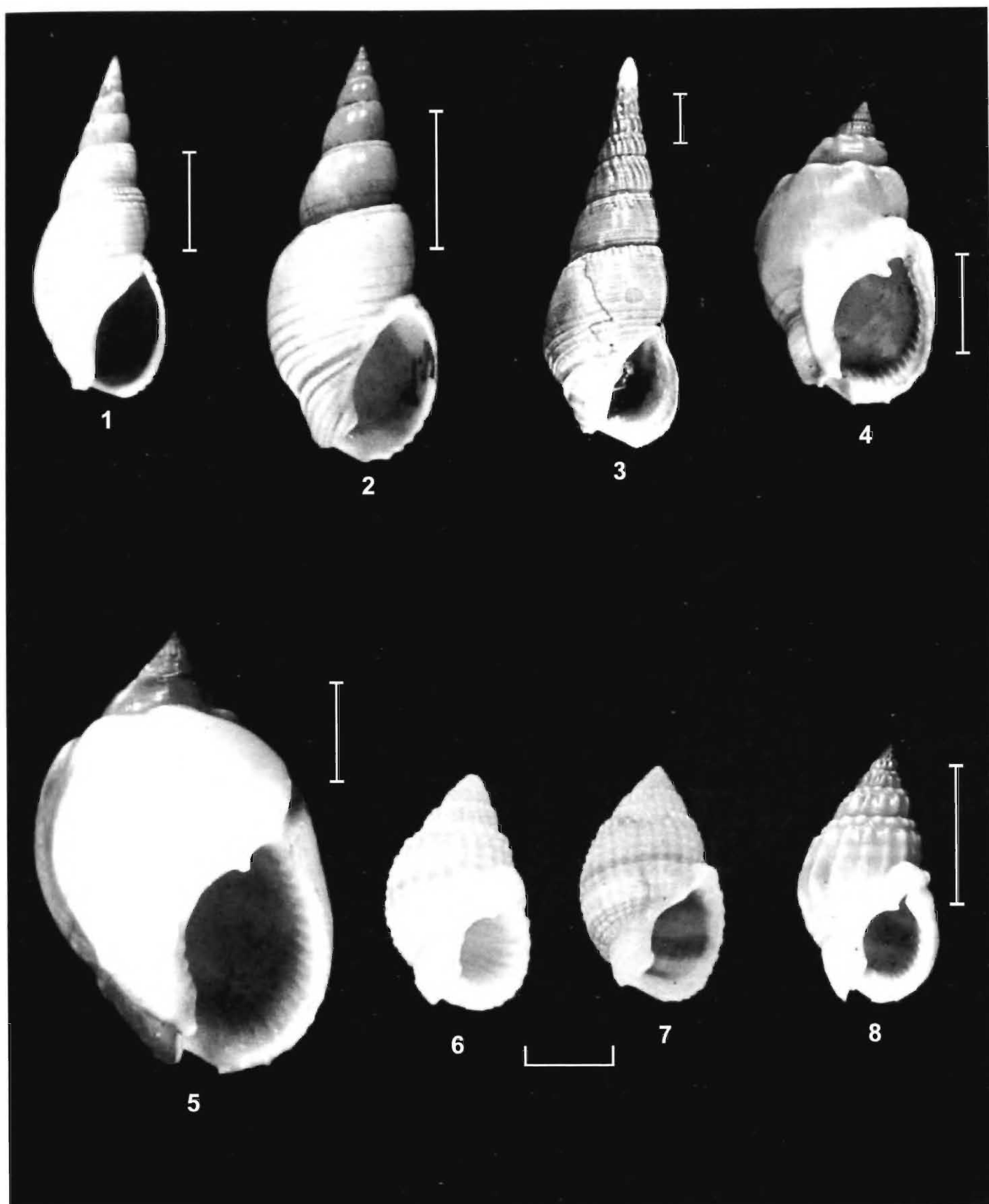
- 1,2. *Cantharus tranquebaricus* : Bhimilipatnam, M 3451; 3. *Cantharus spiralis* : Bombay, M 3452; 4. *Cantharus undosus* : Dwaraka, Gujarat, M 21617/4; 5. *Cantharus fumosus* : Indian Ocean, M13583/2; 6. *Cantharus wagneri*; 7. *Nassaria pusilla* (*N. Nivea*); 8. *Clea bockii* : Narasapur, West Godavari Dist., Andhra Pradesh, M 20803/4; 9. *Nassaria laevior* : Sta. 237, Andamans, Marine Survey; 10. *Phos senticosus* : Andamans; 11. *Nassaria acuminata* (*N. suturalis*); 12,13. *Phos textum* : Ganjam coast, Orissa.

Plate 62 : Columbelloidea



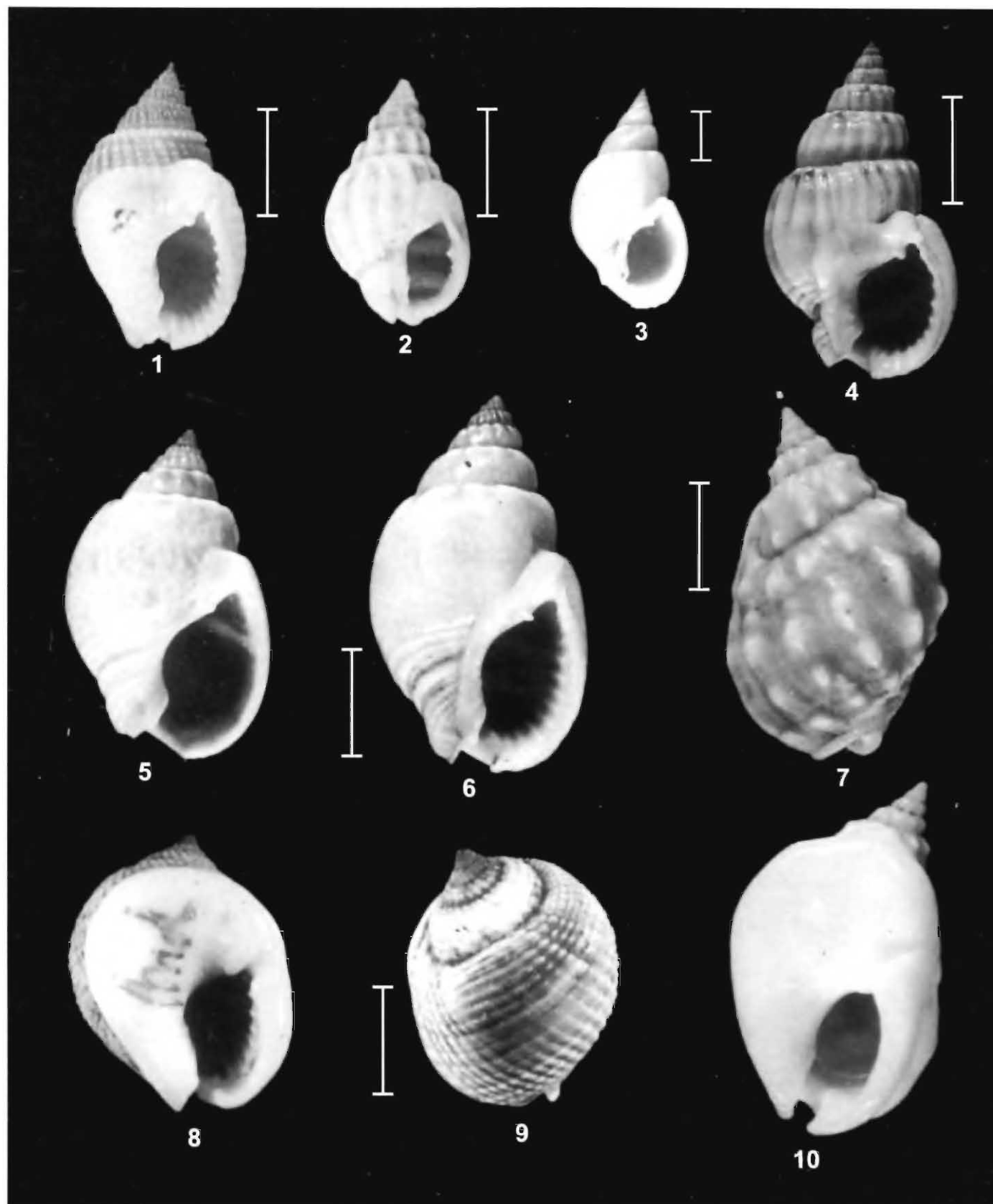
1. *Pyrene philippinarum*; 2, 3. *Pyrene scripta*; 4, 5. *Columbella turturina* : Andamans; 6, 7. *Pyrene flava* : Andamans; 8, 9. *Mitrella blanda*; 10, 11. *Columbella duclosiana* : Singapore; 12. *Euplicia varians* : Lakshadweep; 13. a-d *Mitrella puella* *Pyrene testudinaria* x.

Plate 63 : Nassariidae



1. *Bullia vittata* : Puri , Orissa, M 23794/5; 2. *Bullia tranquebarica* : Pondicherry, M 23722/5;
 3. *Bullia melanoides*; 4,5. *Nassarius coronatus* : Indian Seas, M 3664; 6,7. *Nassarius albescens*
gemmuliferus; 8. *Nassarius distortus* : Andamans, M 3726; 9. *Nassarius conoidalis* x.

Plate 64 : Nassariidae



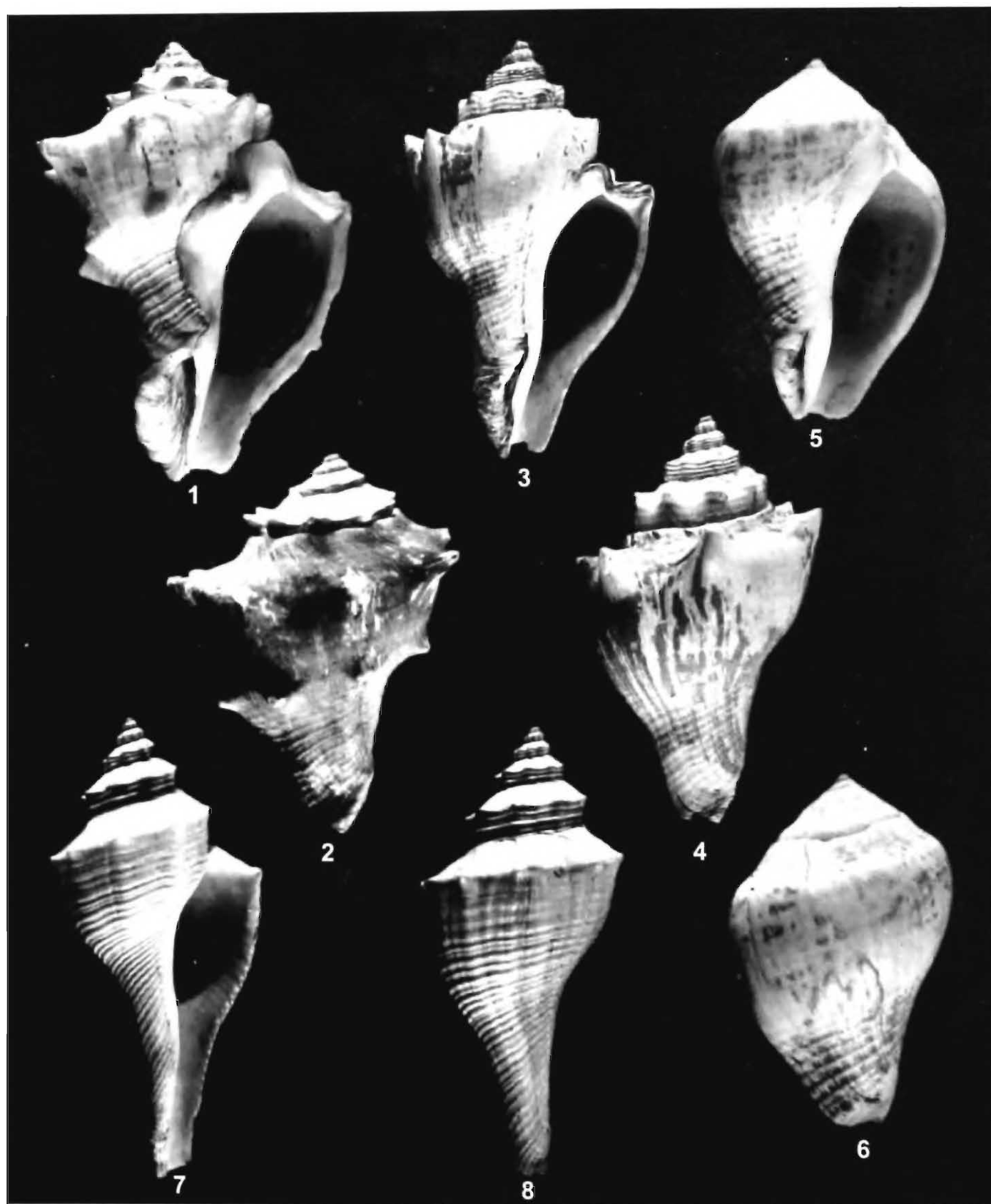
1. *Nassarius livescens*; 2. *Nassarius jacksonianus*; 3. *Nassarius comptus*; 4. *Nassarius nodifera* : Indian Seas, M3726; 5,6. *Nassarius lurida* : M 3757; 7,8. *Nassarius granifera* : M 18504/3; 9,10. *Nassarius globosus* : Andamans, M 3644.

Plate 65 : Nassariidae



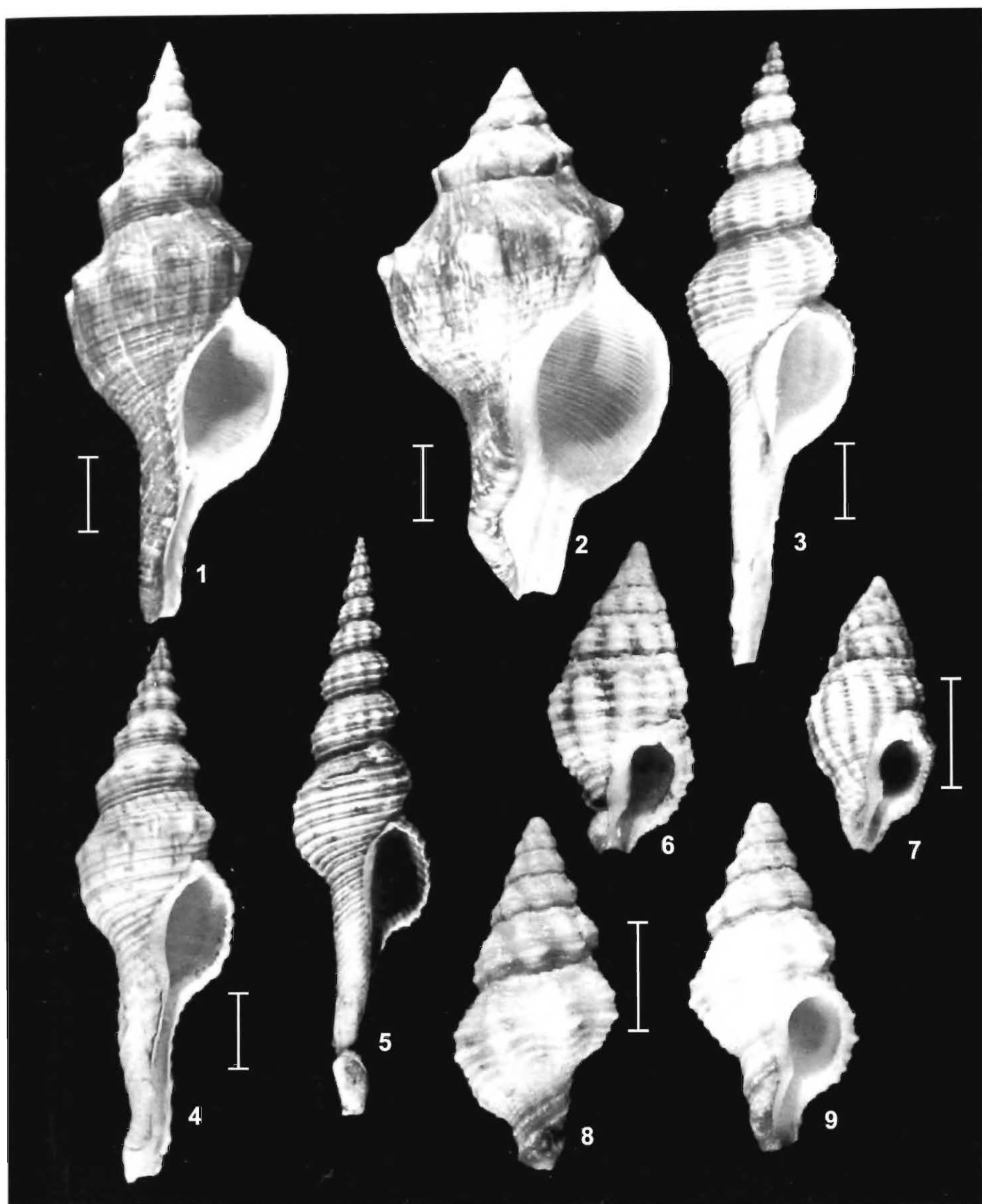
1,2. *Nassarius pullus* : M 18670/3; 3. *Nassarius olivaceus* : M 3674; 4. *Hebra horridus (curta)* ;
5. *Nassarius foveolatus* : M 18489-94/3; 6,7. *Nassarius subconstrictus* : M23630/4, Chilka Lake;
8, 9. *Nassarius stolatus*. M 23775/4, Chandipur, Orissa. *Nassarius dorsatus*.

Plate 66 : Melongenidae



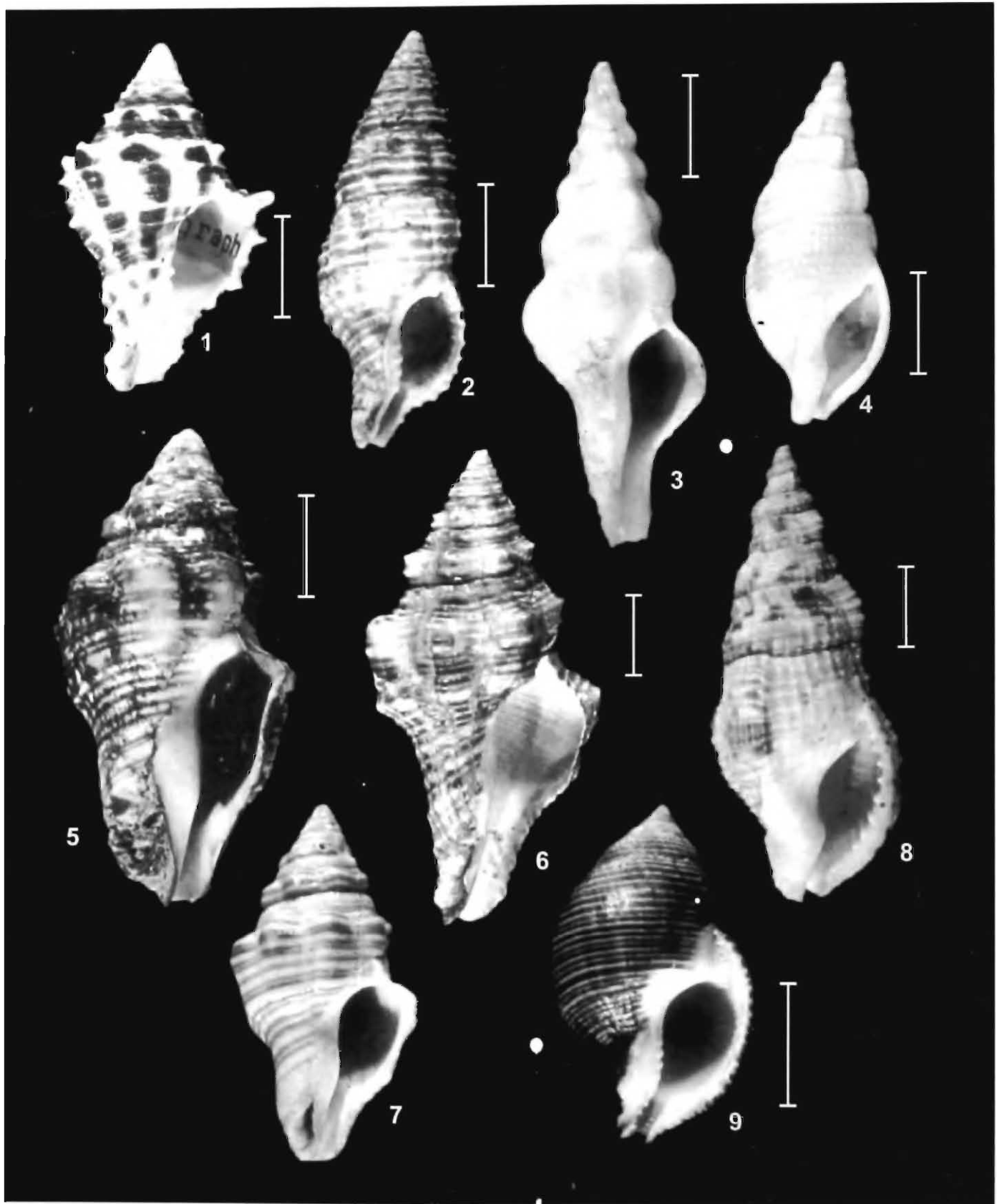
1,2. *Pugilina (Hemifusus) carnaria*; 3,4. *Pugilina (Hemifusus) cochlidium*; 5,6. *Pugilina ternatanus*
7,8. *Volema paradisciaca*.

Plate 67 : Fasciolariidae



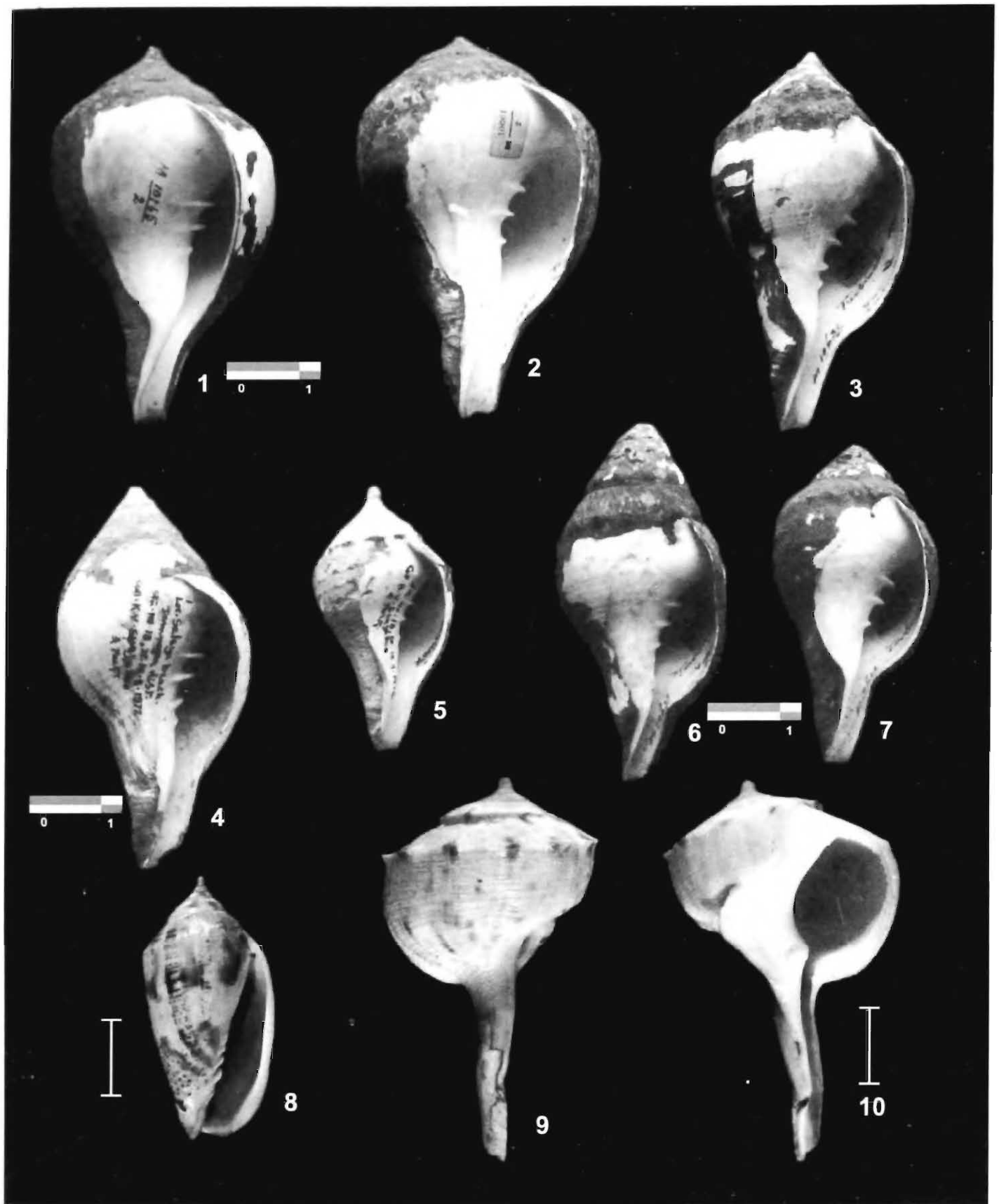
1. *Pleuroploca filamentosa* : Andamans; 2. *Pleuroploca trapezium* : Port Canning, West Bengal; 3. *Fusinus forceps*; 4. *Fusinus nicobaricus* : India, M 3390; 5. *Fusinus colus* : off Gopalpur, Orissa, M 4711-12/1; 6. *Peristernia violacea* : Andamans, M 3783; 7. *Peristernia nassatula* : Andamans, M19114/3; 8,9. *Peristernia ustulata* : Andamans, M 3784.

Plate 68



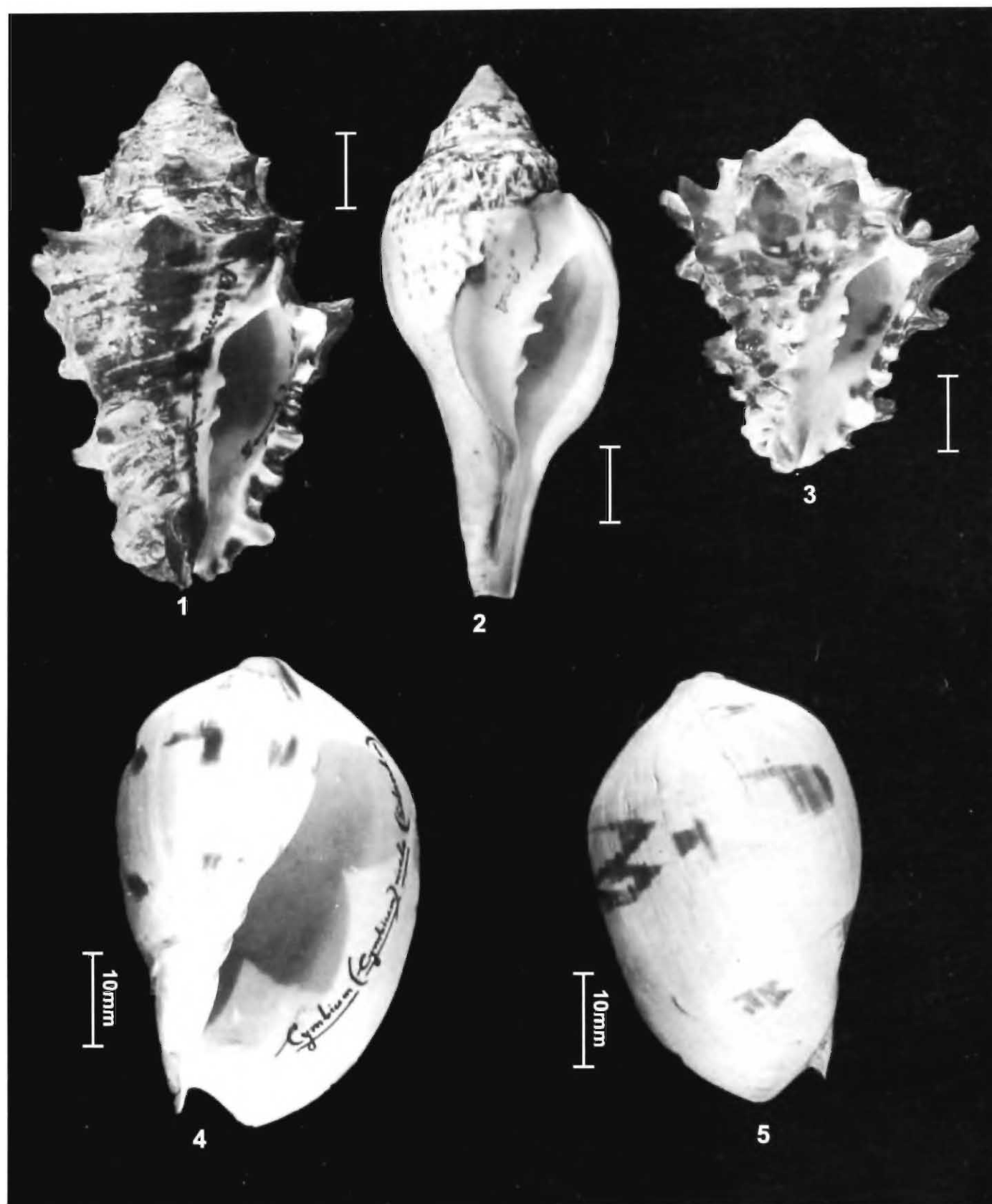
1. *Latirus belcheri* : Kavaratti, Lakshadweep, M 23687/4; 2. *Latirus craticulatus* : South Andaman, M 19109/3; 3. *Peristernia nodata* : Andamans, 3805; 4. *Colubraria tortuosa* : Andamans, 2660; 5,6. *Latirus gibbulus* : Andamans, M 3268 & 3269; 7. *Latirus polygonus* : Andamans, 3797; 8. *Colubraria muricata* : Andamans, M 2634; 9. *Laterolagena smaragdulus* : Car Nicobar, M 21413/3.

Plate 69 : Vasidae



1. *Turbinella pyrum* var. *obtus* : Pulicat; 2. *Turbinella pyrum* var. *obtus* : Nagapattinam; 3. *Turbinella pyrum* : Porbander, Gujarat; 4. *Turbinella pyrum* : Salaya, Jamnagar, Gujarat. 5,6,7. *Turbinella pyrum* var. *acuta* : Sri Lanka (Talaimannar); 8. *Harpulina lapponica* : Gulf of Mannar; 9,10. *Tudicla spirillus*.

Plate 70 : Vasidae



1. *Vasum ceramicum* : Neil Island, South Andaman; 2. *Turbinella pyrum fusus* : Rutland Island, South Andaman; 3. *Vasum turbinellus* : Neil Island, South Andama; 4,5. *Melo melo* : Madras, Tamil Nadu.

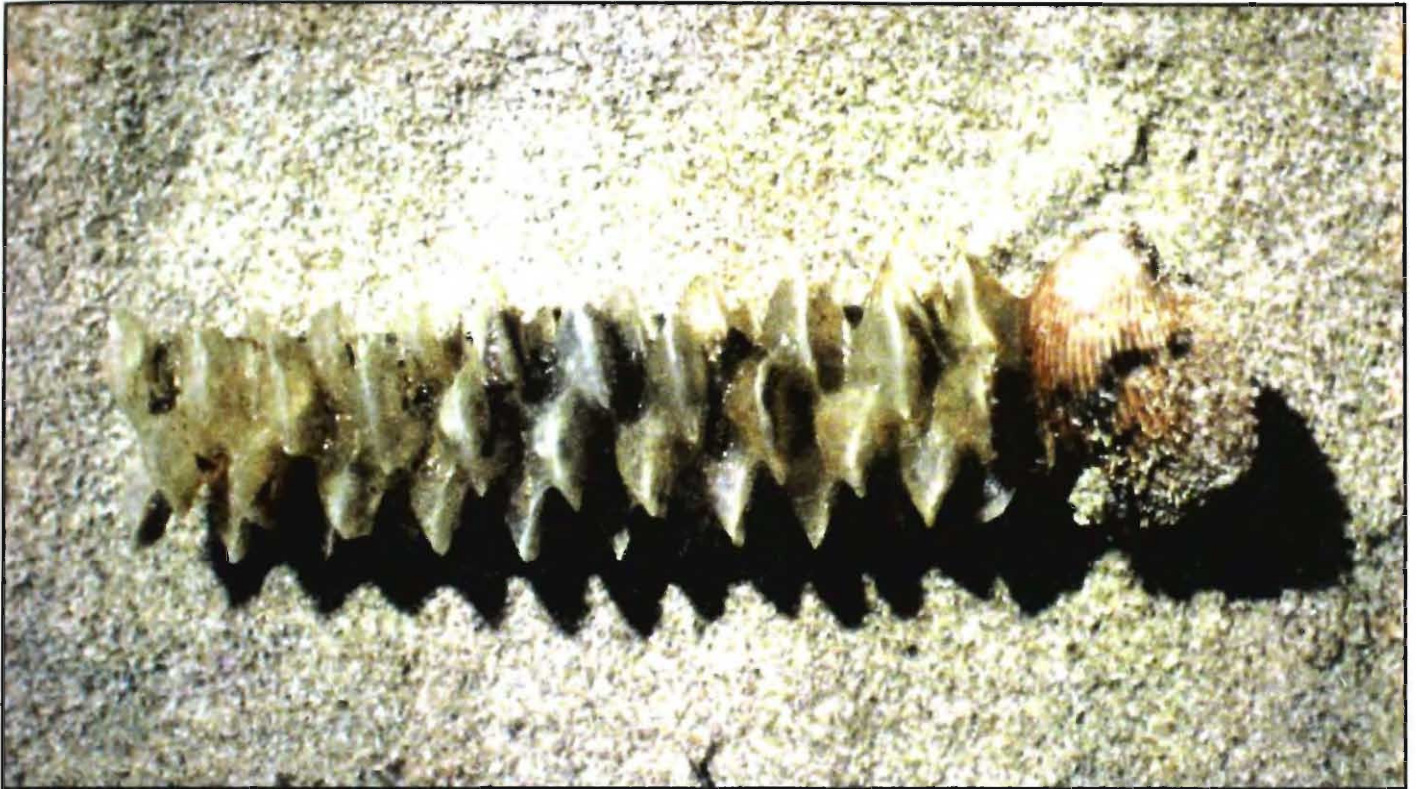


Fig. 35. Egg case of *Tudicla spirillus*.



Fig. 36. *Turbinella pyrum* with animal.

to the columellar muscles. Operculum is horny and elongated. Shell as a rule is dextral (right handed spiral) but rarely sinistral forms may occur. In Tamil Nadu the former is known as Edampuri and the latter as Valampuri chank.

A distinct subspecies *Turbinella pyrum fusus* Sowerby (Pl. 70, fig. 2) occurs at a depth of 15 m in Andaman Sea. It is characterized by a distinct high spire, angular shoulder and elongated anterior canal.

Sexes are separate. In Gulf of Mannar the chank breeds from January to March. Eggs are deposited in 25 to 30 capsules and the total mass bears striking resemblance to a ram's horn. Young ones with 15 mm long shell erupt out of the capsules and fall on to the bottom. The whole brood consists of about 200 to 250 juveniles. Since there is no free-swimming larval stage in its development the chank does not get dispersed over long areas. The chank may grow to a maximum of 260 mm shell length.

Chanks are gregarious and localised in distribution. They prefer sandy bottom mixed with moderate mud, where their food, tubicolous polychaetes, is available in plenty. Chank beds are found at a depth of 30 to 50 m in the Gulf of Mannar, in shallow waters of Gulf of Kachchh and in Andaman Islands and Palk Bay.

Six kinds of chanks are recognised in commerce and trade. They are Thuthukkudi from Thirunelveli, Ramesary from Ramanathapuram, Duvani from Trivandrum, Garbakki from Madras, Potti from Sri Lanka and Surti from Gujarat. Of these, Thuthukkudi, Duvani and Surti are supposed to be of good quality and are in maximum demand.

The story of chank and its uses can form a separate volume by itself. It has a very long history dating back to Indus Valley Civilisation. Several ornaments like bangles, rings, necklaces, a variety of shell crafts, etc. are made out of the shell. It is also used as an amulet against evil eye. Chanka Bhasma (burnt chank powder) is used in ayurvedic medicine. In Hindu temples chank is blown to invoke God at the time of worship. It is also used as a libation vessel and water poured from a chank is considered as 'holy'

Although there are a few chank-based industries in Tamil Nadu, the main centres are in West Bengal and Bangladesh. According to some reports there were about 5000 families dependant on chank shell industry in West Bengal alone, spread over in the districts of Howrah, Bankura, Burdwan, 24 Parganas and Calcutta.

Chanks are not only in demand in our country but are also exported to Italy, Spain, France and U.S.A. Majority of the chanks are fished from the Gulf of Mannar while a few thousands are collected from the Gulf of Kachchh and those from Andamans are commercially insignificant. In Gulf of Mannar the fishing rights are leased out by the Government of Tamil Nadu, while in Gulf of Kachchh, Dept. of Fisheries, Govt. of Gujarat purchases the shells

from 'wagher' fishermen and auctions the accumulated shells to dealers at the end of the year. The whole operation is carried out under the supervision of Government officials who would ensure that no undersized shells (less than 6 cm length) are collected. The fishery of this highly esteemed shell has its ups and downs and the annual production figures are highly fluctuating. Since the entire fishery is based on natural populations the yield is falling far short of rise in demand for chanks. As a result there is a crisis in the domestic market, especially in West Bengal. The export trade had also fallen from 55 tonnes in 1976 to 18 tonnes in 1977. Bangladesh, which once used to import chanks from India, is now dependent on the supply from Sri Lanka.

Sinistral chank or Valampuri chank is a rarity but devout Hindus are zealous to possess one such. Unscrupulous businessmen have devised a method to trick the innocent people by substituting a sinistral lightning whelk, *Busycon contrarium*. It is a natural sinistral species and occurs in abundance in the Gulf of Mexico. It is imported at a cheaper rate and sold in the name of Valampuri chank, which fetches a higher rate. A few of these shells i.e. lightning whelks, have found their place in temples.

The Indian chank has localised distribution extending from southeast coast through Sri Lanka to Southwest coast in Kerala and in the Gulf of Kachchh, Gujarat. It was also reported from the St. Martin Island, off Bangladesh.

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Family OLIVIDAE

Olive Shells

Shell is variable in size, small to large but usually not more than 80 mm in height, rarely reaching up to 100 mm. It is cylindrical or subcylindrical in shape, with spire being short or elevated and sutures grooved or channelled. Shell is smooth, hard and highly glossy. Aperture is elongate to ovate, with wide, deep and short anterior canal, and indistinct posterior canal. Outer lip is thick and smooth. Columella is with callus, and folds anteriorly and often obliquely plicate. Sometimes a fasciole may also be present. Periostracum and operculum usually are absent. The shells display brilliant colours, which are highly variable within the species.

Cephalic region is small with reduced tentacles, which may or may not bear eyes. The animal has a powerful foot which exceeds the length of the shell when it actively crawls. It is divided into an anterior propodium and a voluminous posterior metapodium. The sides are expanded (parapodia) and extend over the shell laterally. Mantle cavity consists of a monopectinate ctenidium, bipectinate osphradium and a hypobranchial gland. Proboscis is pleurembolic bearing a distal buccal cavity. Radula is rachiglossate type (1-1-1). A gland of Leiblein is present in the oesophagus.

Sexes are separate. Male has a dorso-ventrally flattened penis and a closed pallial sperm duct. Female possesses a gonopericardial duct, a distal bursa copulatrix and an ingesting gland. Eggs are laid in capsules and the development has a pelagic veliger larva.

Olives are carnivorous and feed on living and dead tissue. They feed mostly on bivalves, crustaceans and other invertebrates. They usually are offshore forms with a few species occurring buried in intertidal zone of sandy beaches, lagoons and near coral reefs. The family is divided into four subfamilies that include a total of about 16 genera and 200 species. The systematics of Indian olives is poorly known and their identification becomes often very difficult. There may be more number of species than some of the more common species described below.

Subfamily OLIVINAE

Oliva annulata Gmelin, 1791

(Pl. 72, fig. 8, 9)

Shell of medium size, up to 35 mm in height, spire high and narrow, suture deeply channelled, upper part of the body whorl noticeably angled showing sharp shoulder, thickened outwardly along the edge of the outer lip, columella plicate. Cream coloured and ornamented with small blotches and usually a row of spots at sutures, aperture orange, apex yellow.

The Indian form belongs to forma *mantichora* Duclos, 1835

India : Andamans. Tropical Indo-Pacific.

***Oliva caerulea* (Roeding, 1798)**

(Pl. 72, fig. 12, 13)

Shell moderately large, up to 60 mm in height, spire high and calloused, suture narrow and deep, slightly inflated in the middle. Columella with strong callus and three to four ridges on the anterior and thin callus and plications on the posterior. Colour variable, white, profusely spotted with blue-gray and golden yellow, often with two faint spiral bands, aperture violet, columella white, fasciole with yellow tinge.

India : Tamil Nadu, Andamans. Indo-Pacific.

Synonym : *Oliva episcopalis* Lamarck, 1811

***Oliva oliva* (Linnaeus, 1758)**

(Pl. 71, fig. 2 and Pl. 72, fig. 4)

Shell of medium size, up to 30 mm in height, thick, polished, spire very short, sutural groove narrow and deep. Aperture narrow, columella with callus on the anterior two thirds and with oblique, uneven plaits. Colour highly variable, creamy white, brown, black or yellow, ornamented with dark spots, blotches or without any markings, columella white, aperture brown, white or pink.

India : Maharashtra : Bombay, Deogad; Lakshadweep, Tamil Nadu : Madras, Cuddalore, Porto Novo, Tranquebar etc.; Pondicherry, Andhra Pradesh : Visakhapatnam, Kakinada; Orissa : Puri, Balasore; common in the intertidal zone of sandy beaches. Indo-Pacific.

Synonym : *Oliva ispidula* (Linnaeus, 1758)

***Oliva miniacea* (Roeding, 1798)**

(Pl. 72, fig. 3)

Shell large, up to 90 mm in height, heavy, solid, spire short to moderate, sutures deep and channelled. Aperture rather wide, columella with three to four plaits anteriorly and denticulate throughout. Colour variable, mostly creamy yellow, ornamented with irregular, wavy brownish gray axial lines or dots, two broad, dark chocolate broken bands, one below the suture and the other at the middle of the body whorl, aperture characteristically rich orange, a narrow, cream coloured axial band extending from anterior to posterior end along the outer lip, columella white, fasciole band dark brown.

India : Andaman and Nicobar Islands. Indo-Pacific.

Oliva sericea (Roeding, 1798)

(Pl. 71, fig. 5)

Shell moderately large, up to 70 mm in height, spire very low with pointed apex, suture narrow and deeply channelled, with a raised callous projection, anterior end of columella calloused. Aperture narrow, outer lip extends posteriorly to level with the shoulder of the body whorl, columella with plicae. Surface ornamented with three dark coloured bands on creamy white background, two broad, blackish-brown spiral zones.

India : Andhra Pradesh, Andamans. Indo-Pacific.

Oliva vidua (Roeding, 1798)

(Pl. 72, fig. 1)

Shell of medium size, up to 50 mm in height, spire stunted, suture deeply and narrowly grooved, body whorl rather inflated posteriorly. Columella with broad callus on the anterior end gradually thinning towards the posterior half, with ridges throughout, posterior end of the columella extended to level with the beak-like extension of the outer lip which extends to level with the spire. Colour highly variable, brown with wavy dark brown lines and zigzag pattern, often with a dark spiral band in the middle, aperture usually white.

India : Orissa : Chatrapur, Puri; Andhra Pradesh : Bheemunipatnam, Visakhapatnam; Tamil Nadu : Madras, Tranquebar, Pamban; Andamans. Indo-Pacific, offshore, common, but not as common as *O. oliva*.

Synonym : *Oliva maura* Lamarck, 1811

Olivancillaria gibbosa (Born, 1778)

(Pl. 72, fig. 14)

Shell moderately large, up to 60 mm in height, stout, thick, elongately ovoid, spire short but acuminate, body whorl inflated, suture channelled. Aperture rather wide, with slit-like posterior canal, columella with thick callus extending over to the penultimate whorl, anteriorly with oblique close-set ridges and posteriorly smooth, fasciole strong and raised. Colour pale yellowish brown with a prominent yellow band at the base, mottled or streaked with black spots, sometimes whitish with zigzag transpiral brownish bands, columella yellowish-white, aperture bluish-white.

India : Gujarat, Maharashtra, Tamil Nadu (very common), Pondicherry (common), Andhra Pradesh : Visakhapatnam, Kakinada; Orissa, West Bengal, Andaman and Nicobar Islands. Indian Ocean.

Subfamily AGARONIINAE

Agaronia nebulosa (Lamarck, 1811)

(P1. 72, fig. 5)

Shell of medium size, up to 40 mm in length, slender and elongate, spire narrow and acutely elevated, suture deep. Aperture elongate and anteriorly wider, columella with strong and broad callus anteriorly and weakly calloused posteriorly, columellar plaits stronger and twisted at base. Colour pinkish white ornamented with zigzag brown lines and oblique concentric streaks just below suture.

India : Gujarat : Okha; Diu, Maharashtra, Tamil Nadu (common), Pondicherry (common), Andhra Pradesh, Orissa. Indian Ocean to Indonesia.

Synonym : *Oliva subulata* Reeve, 1858.

Subfamily ANCILLINAE

Amalda ampla (Gmelin, 1791)

(P1. 71, fig. 4 and P1. 72, fig. 6, 7)

Shell of medium size, up to 35 mm in length, slender and elongate, spire elevated with a pointed apex, sutures almost covered with callus leaving fine impressions. Aperture wide, columella twisted in the middle with deep furrow, two grooves extend on to body whorl. Surface highly polished, ivory-white to creamy-brown, often tinged with orange brown towards the spire and apex.

India : West Bengal : Ganga Sagar, Bakkhali, Digha; Orissa, Andhra Pradesh : Bheemunipatnam; Tamil Nadu : Madras, Tuticorin, Tiruchendur, Pamban, Krusadai Is., Kundugal Point, Kanya Kumari. Indian Ocean.

It is common on sandy beaches along the east coast of India from intertidal zone to about 20 m depth. Once it was very abundant on Digha beach, West Bengal, but indiscriminate collection of shells for the preparation of curios has lead to the total absence of the species on the beach.

Ancilla monilifera Reeve, 1864

(P1. 72, fig. 10, 11)

Shell small, up to 15 mm in height, spire elevated, sutures shallow, thin. Aperture rather bifid anteriorly, outer lip thin, columella concave basally and marked with a fasciolar ridge, callus thinly extending over up to the penultimate whorl. Sculptured with fine axial striations, a

broad, oblique spiral band at the base. Colour cream, ornamented with a row of dark brown dashes below the suture, spiral band at the base, with dark brown, distantly placed axial streaks, aperture white, with a brownish tinge, surface with irregular dark brown spots.

India : Andamans. Elsewhere: Western Australia.

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Family MARGINELLIDAE

Margin Shells

Shell usually is small, up to 20 mm in height. It has ovate to subpyriform shape with large body whorl and elevated to sunken spire. Protoconch is paucispiral. Aperture is long and narrow with thickened outer lip that may be smooth or denticulate. Columella has three to six strong plicae. Anterior siphonal canal is short and truncate. Posterior one is indistinct. Surface is glossy and smooth. There is no operculum.

There is a pair of long cephalic tentacles bearing eyes at their outer bases. Foot is long, narrow and truncated anteriorly. Mantle extends over to the shell and covers a greater part of it. Mantle cavity consists of monopectinate ctenidium and a bipectinate osphradium. Proboscis is pleurembolic with a distal buccal cavity. There is a small Leiblein gland. Radula has a narrow central and no laterals (0-1-0).

Sexes are separate. Male has a more or less pointed penis. There are no gonopericardial ducts. Female has seminal receptacles or sperm sacs. Eggs are laid singly and development may be direct.

Margin shells are carnivores, feeding on clams and other snails. They occur in shallow waters to depths. The family is divided into three subfamilies namely, Marginellinae, Cystiscinae, and Marginelloninae, which include a total of about 32 genera and 650 species. These are common on the West African and Australian coasts. In India these are less known.

Subfamily MARGINELLINAE

Marginella angustata Sowerby, 1846

(P1. 71, fig. 6 and P1. 73, fig. 2)

Shell small, up to 20 mm in height, cylindrically ovate, spire flat and calloused. Aperture narrow, outer lip thickened and smooth. Columella with four oblique folds at the anterior end and the anterior-most smallest. Surface smooth, glossy, ash-white with grayish brown spiral bands crossed by bluish axial lines.

India : Maharashtra : Bombay; Lakshadweep, Tamil Nadu (very common); Pondicherry, Andhra Pradesh : Visakhapatnam; Orissa : Ganjam; Andamans, common. Indian Ocean, deep water.

Marginella ventricosa G. Fischer, 1807

(Pl. 73, fig. 3)

Shell small, up to 20 mm in height, ovate, solid, spire rather exerted, whorls roundly convex at the upper part. Outer lip thickened with callus and reflected, columella with five distinct plaits at the anterior half, surface smooth, light yellowish- brown.

India : West Bengal : Sand Heads; Orissa : Puri; Tamil Nadu : Madras; on mud in shallow water, not common. South Asia.

Fig. 37. *Marginella*.*Marginella loebeckeana* (Weinkauff,)

(Pl. 71, fig. 5 and Pl. 73, fig. 4)

Shell small, solid, spire slightly elevated. Aperture narrow, wider at the anterior end, outer lip thickened with many small denticles on the inner margin, columella with five strong plaits. Shell surface glossy, uniform light gray, outer lip white inside, columellar callus yellowish at the anterior end.

India : Pondicherry, Andamans. Indian Ocean, not common.

Persicula persica

(Pl. 73, fig. 1a, b)

Shell small, 15 mm in height, spire slightly elevated, body whorl almost straight sided. Aperture narrow and elongate, outer lip slightly thickened and smooth, columella with 3–4 small plaits. Surface smooth. Colour white.

India : Andamans. Indian Ocean.

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Family HARPIDAE

Harp Shells

Shell is large, thick and heavy, with a large body whorl. It has a low and short spire with an acute apex. The aperture is broadly or narrowly ovate. Anterior canal is very short or absent and the anal canal is distinct in the form of a shallow sinus. Columella is with callus and glazed, without any plications. Surface is sculptured with strong axial ribs, which end in sharp points on the shoulder. Spiral sculpture is either obsolete or absent. Shell has a beautiful colour pattern with bright reddish brown to pink.

Foot is very large and fleshy. It is divided into anterior propodium and posterior pointed metapodium. Head bears slender and pointed tentacles, with eyes at the anterior end of a lateral enlargement at the base of tentacles. Proboscis is pleurembolic type in which only the basal part is invaginable. Radula is minute and stenoglossate. Mantle lobes cover the whole shell. Sexes are separate. Male is with a compressed penis.

Harp Shells occur in the sandy part of the reef among rocks and coral in shallow water. These are nocturnal and carnivorous, feeding on small crabs living in the sand.

It is a small family divided into two subfamilies, namely Harpinae (2 genera) and Moruminae (1 genus), which include a total of about 40 species. The subfamily Harpinae is represented by its nominate genus in India.

Harpa amouretta Roeding, 1798

(Pl. 73, fig. 6, 7)

Shell of medium size, smaller than in other two species, up to 45 mm in height, slender with a raised spire. Aperture narrow, columella simple without significant parietal callus, fasciole long and narrow. Sculptured with about thirteen axial ribs pointed at the shoulder. Colour white, ribs crossed by pairs of dark brown lines enclosing yellow-brown, the interstices between ribs dull brown, columella fawn anteriorly, with a brown spot near the anterior end and with a brownish blotch in the middle.

India : Tamil Nadu : Tranquebar; Andaman and Nicobar Islands. Widely distributed in the Indo-Pacific.

Synonym : *Harpa minor* Lamarck, 1822

Harpa davidis Roeding, 1798

(Pl. 73, fig. 5)

Shell moderately large, up to 85 mm in height, light, spire moderate, body whorl expanded. Columella smooth, with a twisted fasciole. Sculptured with about eleven ribs ending in small

sharp spines on shoulder. Colour fawn pink with lighter pink spiral bands, ribs with single, reddish brown lines, columella dark brown on the posterior and with a small brown mark on the anterior.

India : Tamil Nadu : Madras, Tranquebar, Pamban, Rameswaram; Andaman and Nicobar Islands. Indian Ocean to Northwestern Sumatra.

***Harpa harpa* Linnaeus, 1758**

(not figured)

Shell large, up to 90 mm in height, ovate, spire moderate, body whorl with a square shoulder. Sculptured with twelve, widely spaced ribs ending in sharp spines on the shoulder, interspaces with fine axial striae. Columella with short, sharp teeth in the posterior part, fasciole strong and twisted. Colour flesh pink, ribs decorated with dark brown lines arranged in twos, threes or fours, interspaces with white and red-brown rows of dashes and V-shaped marks, outer lip with brown marks where groups of lines end on last rib, columella fawn coloured with central brown mark, smaller blotch posteriorly on parietal wall and another small one at its anterior end.

India : Tamil Nadu, Pondicherry. (East Africa to Tonga (Rehder, 1973).

***Harpa major* Roeding, 1798**

(Pl. 73, fig. 8, 9)

Shell of medium to large in size, up to 80 mm in height, broadly oval, solid, body whorl large, spire conical. Aperture large, ovate, outer lip simple and gently arcuate, columella bordered by a strong rounded fasciole, ribs continue as ridges on the columella, anterior canal broad and posterior a shallow sinus. Protoconch consists of 3 ½ smooth whorls, post nuclear whorls with sharp axial ribs and two or three spiral cords, the uppermost gives the whorls a shouldered appearance, body whorl with twelve axial ribs ending in spines on the subsutural ramp, interspaces with fine axial striae. Colour of the shell pinkish flesh colour, spaces between the ribs ornamented with axial festooned pattern of white, ribs with or without dark brown spiral lines, columellar and parietal area with a large deep chestnut blotch, more or less divided in the middle of the parietal wall, the lower part continues down to the base of the columella.

India : Tamil Nadu : Madras; Andamans. Widely distributed in the Indo-Pacific, offshore species.

Synonym : *Harpa conoidalis* Lamarck, 1822

REFERENCE

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Family MITRIDAE

Miters

Shell is medium to large in size. It is solid and elongately ovate, cylindrical or fusiform. Spire usually is high with a multispiral protoconch. Aperture is more or less elongate with a distinct anterior siphonal canal. Posterior siphonal canal is indistinct or notched. Columella has 3 to 11 distinct, close set oblique folds and the first one is larger and longer than the second one. Surface of the shell may be smooth or may bear axial ribs, spiral grooves, cords and granules. There is no operculum.

Head bears a pair of elongate tentacles with eyes at their outer bases. Foot is small and triangular. Proboscis is very long and has a peculiar epiproboscis, which serves as a vehicle for the salivary gland secretions. Alimentary canal is very distinctive type. A pair of salivary glands is present. Accessory salivary gland and Leiblein gland are absent. Midoesophagus is very short and not conspicuously glandular. Stomach often is with muscular gizzard, a modified style sac and without caecum. Radula is rachiglossate type with three teeth per each row (1-1-1) or one central (0-1-0) as in *Cylindromitrinae*.

Sexes are separate. Rock and coral dwellers deposit eggs on the rock or coral boulders, whereas sand dwellers deposit them on weeds. Egg capsules are deposited in loose symmetrical clusters. Each cluster may contain about 15-100 capsules, and each capsule contains about 100-500 white or cream or yellow coloured translucent eggs. The incubation period lasts for two weeks, after which a free-swimming veliger with operculum is released. Operculum however disappears in the adult.

The family has a cosmopolitan distribution. Majority of the species live in the crevices or holes of coral reefs. A few may occur on the rocky coasts, while a few are sand-burrowers. The rock and reef dwellers usually are detritus feeders but the sand dwellers are carnivores.

Based on radular and shell characters the family is distinguished into four subfamilies, namely *Mitrinae*, *Imbricariinae*, *Cylindromitrinae* and *Vexillinae*. The family includes about 400 species, of which 45 species are known to occur in India.

Subfamily MITRINAE

Mitra (Mitra) ambigua Swainson, 1829

(Pl. 74, fig. 1)

Shell moderately large, up to 55 mm in length, body whorl proportionately longer than the spire and thick, spire elevated and without radial ribs, sutures distinct. Aperture longer than the

spire, outer lip with 17 to 20 close-set denticles, columella with five oblique folds. Shell surface with spiral ribs enclosing punctate grooves in between. Colour uniformly brownish.

India : Andaman and Nicobar Islands, not very common, intertidal coral reefs.

***Mitra (Mitra) cardinalis* (Gmelin, 1791)**

(Pl. 74, fig. 2)

Shell of medium size, up to 50 mm in length, ovate, body whorl longer than the spire. Aperture longer than the spire, outer lip with 23-35 denticles. columella with five distinct oblique folds. Sculptured with distinctly punctated spiral grooves and axial striae. Colour white with rows of orange brown spots.

India : Andaman and Nicobar Islands, hard coral reef substratum. Madagascar to Polynesia.

***Mitra (Mitra) guttata* Swainson, 1824**

(Pl. 74, fig. 3)

Shell of medium size, up to 38 mm in length, elongately fusiform, solid, whorls seven, spire acuminate. Aperture larger than the spire, columella with five oblique folds. Shell sculptured with punctated spiral lines. Sutures deep brown with a white band on the body whorl.

India : Gujarat, Maharashtra. Madagascar to Sri Lanka.

***Mitra (Mitra) mitra* (Linnaeus, 1758)**

(Pl. 74, fig. 4)

Shell very large, up to 152 mm in length, elongately ovate. Aperture creamy yellow, outer lip denticulate, columella with four oblique folds. Surface with punctate lines. Colour golden yellow with bright orange red rectangular blotches arranged in revolving band.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Mitra (Mitra) stictica* (Link, 1807)**

(Pl. 74, fig. 5)

Shell moderately large, up to 67 mm in length, spire short, whorls six, sutures deep with prominent coronations. Aperture creamy orange, outer lip thick with eleven denticles, the most anterior ones more conspicuous, columella with four oblique folds. Colour white, ornamented with rows of irregular orange blotches.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Mitra (Nebularia) aurantia aurantia* (Gmelin, 1791)**

(Pl. 74, fig. 7, 8)

Shell small to medium in size, up to 35 mm in length, fusiform, whorls six, spire acuminate, suture deep. Aperture long, whitish, outer lip bears 12 to 14 crenulations and a shallow notch in the upper part, columella with four oblique folds. Sculptured with regular prominent spiral ribs. Colour orange or chocolate brown, a white spiral band on the whorls.

India : Gujarat, Andhra Pradesh, Andaman and Nicobar Islands. Indo-Pacific.

***Mitra (Nebularia) aurantia subruppeli* Finlay, 1927**

(Pl. 74, fig. 6)

Shell smaller than in the nominate subspecies, up to 27 mm in length, whorls six, spire smaller than the aperture, sutures deep. Aperture with a thick and smooth outer lip and a columella bearing four to five oblique folds. Sculptured with faintly marked spiral ridges and grooves. Colour chocolate brown with a white band below the suture.

India : Gujarat, Goa. Indo-Pacific.

***Mitra (Nebularia) chrysalis* Reeve, 1844**

(Pl. 75, fig. 3)

Shell small, up to 16 mm in length, ovate, body whorl comparatively larger than the spire; spire less acuminate. Aperture longer than the spire, outer lip contracted in the middle, with seven to eight crenulations, columella with three to four strong oblique folds. Sculptured with spiral ridges and grooves. Colour yellowish brown with a broad interrupted white band.

India : Andaman and Nicobar Islands. Indo-Pacific.

***Mitra (Nebularia) cucumerina* Lamarck, 1811**

(Pl. 75, fig. 1)

Shell small, up to 28 mm in length, spire shorter than the aperture. Outer lip with 11 to 12 crenulations, columella with four oblique folds. Sculptured with elevated keel-like spiral ridges enclosing distinct grooves in between. Colour orange red or reddish brown.

India : Tamil Nadu, Andaman and Nicobar Islands. Red Sea to Polynesia and Hawaii.

***Mitra (Nebularia) luctuosa* A. Adams, 1853**

(Pl. 75, fig. 2)

Shell small, up to 25 mm in length, elongate, spire elongated, longer than the aperture, whorls eight. Outer lip thick and smooth, columella with four oblique folds. Sculptured with

spiral ridges enclosing in between shallow and punctated grooves. Colour brownish with a white band below the suture.

Indian Seas. Gulf of Oman to Hawaii.

Mitra (Nebularia) tabanula Lamarck, 1811

(Pl. 75, fig. 4)

Shell small, up to 11 mm in length, ovate oblong, whorls six. Aperture longer than the spire, outer lip crenulated, columella with three strong and one weak oblique folds. Sculptured with angulated spiral ridges and fine axial striae in the interstices. Colour reddish brown.

India : Andaman and Nicobar Islands. Gulf of Aden to Samoa and Tonga Islands.

Mitra (Nebularia) ticaonica Reeve, 1844

(Pl. 75, fig. 5, 6)

Shell small, up to 20 mm in length, whorls five, spire small in comparison to the body whorl. Aperture longer than the spire, outer lip with 12 to 13 crenulations, columella with four oblique folds. Colour brown to dark tan with a few small, white spots.

India : Andaman and Nicobar islands. East Africa to Polynesia and Hawaii.

Mitra (Strigatella) colombelliformes Kiener, 1838

(Pl. 75, fig. 11)

Shell of medium size, up to 30 mm in length, thick and solid, whorls six, spire short and acute. Aperture longer than the spire, outer lip thick, smooth and sinuate, columella with six oblique folds. Sculptured with shallow spiral grooves. Colour brown with irregular white spots.

India : Indian Ocean to Polynesia.

Mitra (Strigatella) decurtata Reeve, 1844

(Pl. 76, fig. 1)

Shell of medium size, up to 32 mm in length, thick and solid, spire short, whorls five, body whorl smooth in the upper half but with broad spiral ridges on the lower half. Aperture longer than the spire, outer lip sinuated and contracted in the upper part. Columella with four oblique folds. Colour deep chocolate with a conspicuous white band below the suture.

India : Nicobars. Indo-Pacific.

***Mitra (Strigatella) litterata* Lamarck, 1811**

(Pl. 75, fig. 9, 10)

Shell small, up to 22 mm in length, solid, ovate, whorls five. Aperture longer than the spire, outer lip smooth, depressed in the middle and more callous on the inner side. Sculptured with shallow spiral grooves on the lower half of the body whorl. Colour consists of wavy longitudinal plates, chocolate brown streaks and blotches.

India : Andaman and Nicobar Islands. Red Sea and Gulf of Oman to Polynesia and Hawaii.

***Mitra (Strigatella) paupercula* (Linnaeus, 1758)**

(Pl. 76, fig. 2)

Shell small, up to 26 mm in length, ovately oblong, whorls eight, spire acuminate. Aperture as long as the spire, outer lip smooth, columella with four oblique folds. Body whorl smooth, corded at the base. Colour chocolate with wavy white axial streaks.

India : Andaman and Nicobar Islands. Red Sea to Polynesia and Hawaii.

On reef flat, under rocks and boulders, more near the high tide mark.

***Mitra (Strigatella) retusa* Lamarck, 1811**

(Pl. 76, fig. 4)

Shell small, up to 20 mm in length, ovately cylindrical, spire short and blunt, whorls five. Aperture longer than the spire, outer lip thick, slightly compressed in the middle, with 10 to 12 crenulations, columella with four oblique folds. Colour dark reddish brown, ornamented with longitudinal wavy white lines and a narrow white transverse band below the suture.

India : Andaman and Nicobar Islands. Seychelles to Tonga Islands and Samoa.

Under rocks and corals in the reef ecosystem.

***Mitra (Strigatella) scutulata* (Gmelin, 1791)**

(Pl. 76, fig. 3)

Shell of medium to moderately large size, up to 50 mm in length, thick, whorls seven to eight. Aperture with a thick and smooth outer lip and columella bearing four oblique folds. Sculptured with spiral ridges. Colour chocolate brown interrupted by a yellowish spiral band below the suture.

India : Gujarat, Maharashtra : Bombay, Goa, Tamil Nadu : Madras; Andaman and Nicobar Islands. Gulf of Aden to Polynesia.

Subfamily IMBRICARIINAE

Neocancilla circula (Kiener, 1838)

(Pl. 77, fig. 1)

Shell small, up to 33 mm in length, acuminate fusiform, spire sharp, base of body whorl slightly contracted and recurved. Aperture longer than the spire, columella with four oblique folds, outer lip crenulated. Sculptured with strong, sharp and distinct spiral ridges, interstices cancellated with fine axial striae. Colour brown with orange lines on spiral ridges.

India : Maharashtra : Bombay; Tamil Nadu, Andaman and Nicobar Islands. Throughout Indo-Pacific.

Neocancilla granatina (Lamarck, 1812)

(Pl. 77, fig. 2)

Shell of medium size, up to 42 mm in length, narrowly ovate, spire acuminate, whorls seven. Aperture smaller than spire, columella with four weak oblique folds, outer lip weakly crenulated. Body whorl decussate. Colour whitish encircled with light brown lines.

India : Andaman and Nicobar Islands. Throughout tropical Indo-Pacific.

Neocancilla papilio (Link 1807)

(Pl. 77, fig. 3)

Shell of medium size, up to 48 mm in length, elongately ovate, with acuminate spire, whorls seven. Aperture slightly larger than spire, columella with four oblique folds, outer lip crenulated. Surface with spiral ridges separated by broad interstices and traversed by axial striae giving a decussate appearance. Shell white and encircled by light brown lines.

India : Andaman and Nicobar Islands. Indo-Pacific.

Cancilla interlirata (Reeve, 1844)

(Pl. 77, fig. 4)

Shell of medium size, up to 37 mm in length, elongate, spire acuminate. Aperture longer than the spire, columella with five oblique folds, outer lip thin, weakly crenulated. Sculptured with sharp, raised spiral ridges crossed by longitudinal striae forming distinct cancellations, interstices with spiral lirae. Colour white with irregular brown patches.

India : West Bengal, Orissa, Andaman and Nicobar Islands. Mauritius to Polynesia and Hawaii.

Cancilla isabella (Swainson, 1831)

(Pl. 77, fig. 5)

Shell of small to medium size, up to 46 mm in length, elongately fusiform, spire acuminate, suture deep, whorls seven. Aperture slightly longer than the spire, columella with five oblique folds, outer lip weakly crenulated. Sculptured with numerous slender, close-set elevated spiral ridges and fine longitudinal striae giving punctated appearance. Colour light orange or brown.

India : Andaman and Nicobar Islands. Andamans to Philippines and Japan.

Cancilla philippinarum (A. Adams, 1851)

(Pl. 77, fig. 6)

Shell small, up to 32 mm in length, elongately ovate, whorls nine. Aperture longer than spire, columella with six oblique folds, outer lip crenulated. Sculptured with spiral rounded ridges. Shell grayish white.

India : Andaman and Nicobar Islands. Andamans to China Sea and Polynesia.

Subcancilla flammea (Quoy and Gaimard, 1833)

(Pl. 77, fig. 7)

Shell small, up to 26 mm in length, fusiform, spire acuminate, whorls eight. Aperture longer than the spire, columella with four oblique folds, outer lip crenulated. Colour white, ornamented with chestnut brown axial flames. Sculptured with angulated spiral ridges and punctated spiral grooves.

India : Andaman and Nicobar Islands. Mauritius to Fiji.

Shell very much similar to that of the genus *Cancilla* but differs from the latter in radular characters.

Domiporta rufilirata (Adams and Reeve, 1850)

(Pl. 77, fig. 8)

Shell small, up to 30 mm in length, ovately fusiform, spire acuminate and sharp, whorls nine, ventricose, sutures impressed. Aperture longer than the spire. columella with six oblique folds, outer lip thin and without crenulations. Surface sculptured with distinct elevated spiral ridges bisected by punctated axial grooves.

India : Andaman and Nicobar Islands. Andamans to China Sea and Buton.

Imbricaria punctata (Swainson, 1821)

(Pl. 75, fig. 7)

Shell small, up to 15 mm in length, conical, spire depressed, apex mucronate. Aperture very large, columella with six oblique folds, outer lip thin and smooth. Shell without much sculpture except punctate spiral lines on the basal part of the body whorl.

India : Andamans. Mauritius to Polynesia.

Scabricola (Scabricola) caerulea (Reeve, 1844)

(Pl. 77, fig. 9)

Shell small, up to 25 mm in length, pyramidal, whorls nine, spire acuminate. Aperture slightly longer than the spire, columella with five oblique folds, outer lip crenulated. Shell surface granulated or scabrous, spiral grooves narrow and distinct, spiral whorls punctated with axial and spiral striae. Colour white with chestnut bands on the body whorl.

India : Andaman and Nicobar Islands. Andamans to Philippines.

Scabricola (Swainsonia) fusca (Swainson, 1831)

(Pl. 75, fig. 8)

Shell smaller than in *S. caerulea*, up to 18 mm in length, ovate, whorls six. Columella with four oblique folds, outer lip crenulated. Sculptured with punctate spiral grooves. Colour white with a pale white flecked band.

India : Orissa, Pondicherry.

Subfamily CYLINDROMITRINAE

Pterygia crenulata (Gmelin, 1791)

(Pl. 76, fig. 5)

Shell of small to medium size, up to 33 mm in length, oliviform, whorls seven, spire short. Aperture large extending up to the shoulder of the body whorl, columella with seven to nine oblique folds, outer lip thick and crenulated. Sculptured with punctated spiral lirae bisecting axial striae, interstices narrow. Shell white, ornamented with irregular orange brown zones.

India : Andaman and Nicobar Islands. Indo-Pacific, subtidal sands.

Pterygia dactylus (Linnaeus, 1767)

(Pl. 76, fig. 7)

Shell of medium size, up to 40 mm in length, whorls seven. Aperture not reaching the shoulder but longer than the spire, columella with six strong, oblique folds, outer lip thick and

crenulated. Sculptured with shallow spiral striae and decussated spire. Shell white with chestnut or dark-brown bands.

India : Andaman and Nicobar Islands. Tropical Indo-Pacific, subtidal sands.

***Pterygia fenestrata* (Lamarck. 1811)**

(Pl. 76, fig. 6)

Shell small, up to 24 mm in length, cylindrically ovate, spire very short, whorls seven. Aperture longer than the spire, columella with eight to nine oblique folds, outer lip thick and crenulated. Sculptured with sharp, regular, nodulose spiral ridges bisected by obtuse rude axial grooves. Colour white, ornamented with reddish- brown spiral bands.

India : Andamans. Andamans to Polynesia.

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- Subba Rao, N. V. and Dey, A. 1984. Contribution to the knowledge of Indian marine molluscs
1. Family Mitridae. *Rec. zool Surv. India*, Occ. Paper No, 61 : 1-43, 3 pls.

Family CANCELLARIIDAE

Nutmegs

Shell is small to medium in size, which usually is between 20 and 50 mm in height. Shape is elongate ovate to irregularly subtrigonal with a bulged protoconch of a few whorls. Spire is rather elevated with a pointed apex. Aperture usually is ovoid with an indistinct posterior sinus and distinct anterior canal. Outer lip is thickened and bears denticulations on the inner margin. Columella has a well-developed callus and bears three distinct folds. Sculpture consists of axial ribs and spiral cords giving the shell cancellated surface. There is no operculum but has the capacity to close the aperture by secreting mucus and entangling sand grains.

Head bears a pair of tentacles with eyes on swellings at outer bases. Foot is small to large. Proboscis is pleurembolic. Radula consists of a blade like central without marginals or laterals. There is a pair of salivary glands and a Leiblein gland and valve. Sexes are separate. Male has a large penis.

Nutmegs are mostly offshore forms occurring up to great depths. The family is classified into three subfamilies, 39 genera and 500 species, which are mostly Atlantic in distribution. In India it is represented by only a few species.

Subfamily CANCELLARIINAE

Cancellaria asperella Lamarck, 1822

(Pl. 78, fig. 3)

Shell of medium size, up to 40 mm in height, globose to elongate ovate, spire short and apex pointed, sutures narrow and deep, shoulder narrow. Aperture moderately wide, outer lip thick, strong lirations on the interior, columella with callus bearing three folds anteriorly, umbilical pore almost closed by the columella shield, siphonal canal short and broad. Sculptured with numerous axial riblets crossed by alternately thick and thin spiral ridges. Colour pale brown, aperture yellowish or white.

India : Orissa, Andhra Pradesh : Visakhapatnam; Pondicherry, not common. Indo-West Pacific.

Cancellaria quasilla Petit, 1987

(Pl. 78, fig. 1, 2)

Shell small, up to 25 mm in height and 19 mm in width, elongate-ovate, spire raised, protoconch of two and half whorls. Aperture oval, anterior canal and posterior sinus absent, outer lip thick but without denticles, columella with callus and with three columellar folds on

the anterior half. Sculptured with strong axial cords and spiral ribs giving a basket-like appearance (quasilla means wicker basket).

India : Off Travancore, 360 fms. Indian Ocean.

***Trigonostoma scalata* (Sowerby, 1832)**

(Pl. 78, fig. 4)

Shell small, up to 25 mm in height, ovate and globose, shallow wide channel from angular shoulder to rather constricted suture. Aperture wide, lirate within, outer lip thickened, meeting the columella straight posteriorly, a small parietal plication. Columella with a callus shield and three folds anteriorly, umbilicus open and deep, siphonal canal short and shallow. Sculptured with slender, oblique, rather close axial ribs, about 13 to 16 on the body whorl and weak spiral cords becoming nodules on the ribs, axial ribs ending in small nodules on the shoulder. Colour white or light cream, marked on the ribs with crowded dark brown lines, aperture and columella white.

India : Andamans. Indo-West Pacific.

***Trigonostoma scalariformis* (Lamarck, 1822)**

(Pl. 78, fig. 5)

Shell small, up to 20 mm in height, spire short, somewhat stepped up whorls with sutural ramp. Aperture narrow and obliquely oval, outer lip thick and lirate within, columella with callus bearing three oblique folds, base of columella recurved towards aperture bordering the short siphonal canal, umbilical groove partly covered by the columellar callus. Sculptured with fewer, stronger axial ribs separated by fairly broad interspaces, body whorl with nine axial ribs forming crenulations at the shoulder, weak, spiral striae cross the ribs. Colour variable, but usually pale brown, white between shoulder and suture, often with a white spiral band at the middle of the body whorl, columella and edge of outer lip white, aperture lined with brown.

India : Pondicherry, Andamans, not common. Indo-West Pacific.

Synonym : *Cancellaria lamberti* Sowerby, 1832 : Finn, 1985.

REFERENCES

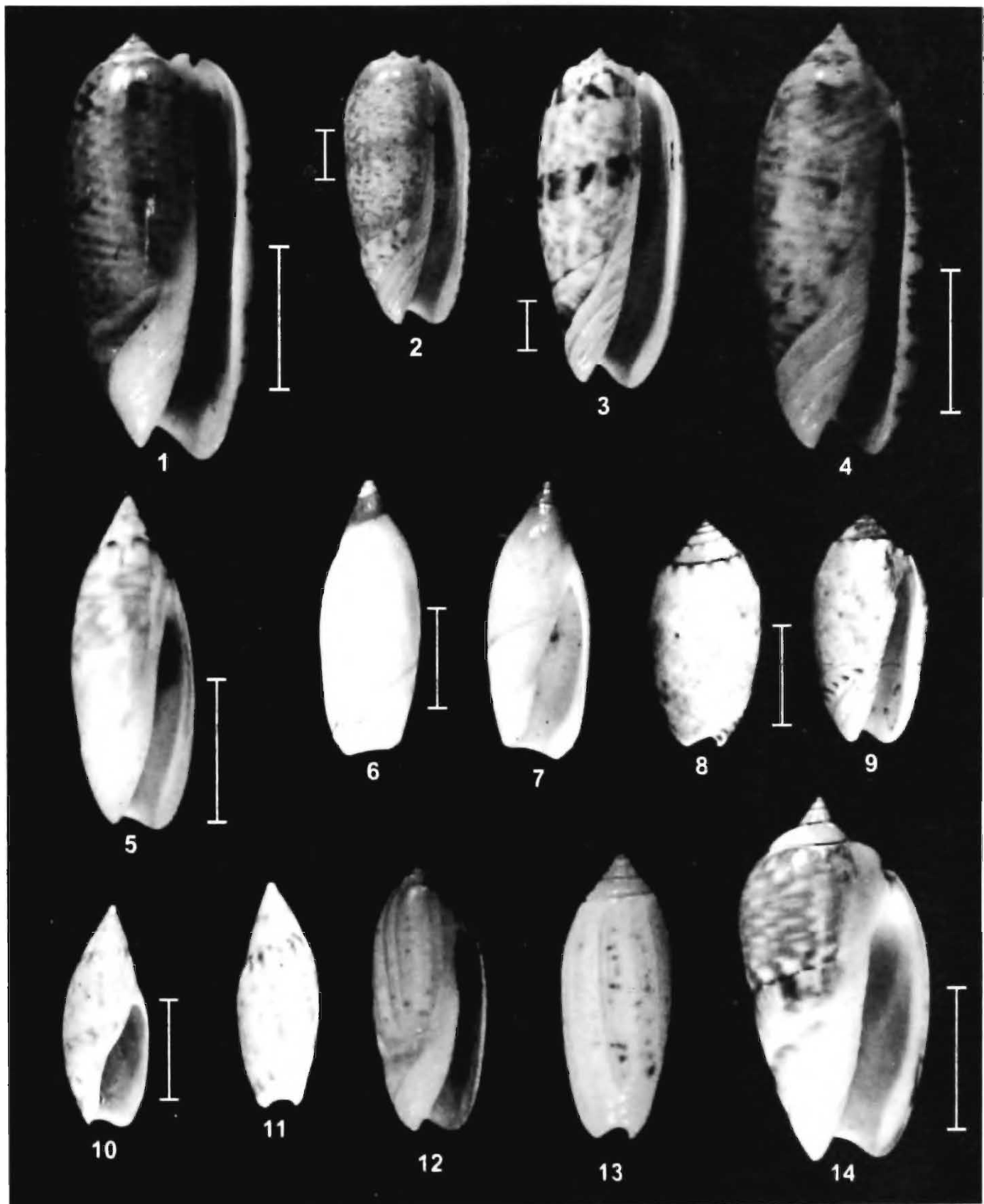
- Petit, R. E. 1987. New names for two species of *Cancellaria* (Mollusca : Gastropoda). *The Nautilus*, **101**(3) : 154.
- Smith, E. A. 1899. See Selected Bibliography p. 378.

Plate 71 : Olividae



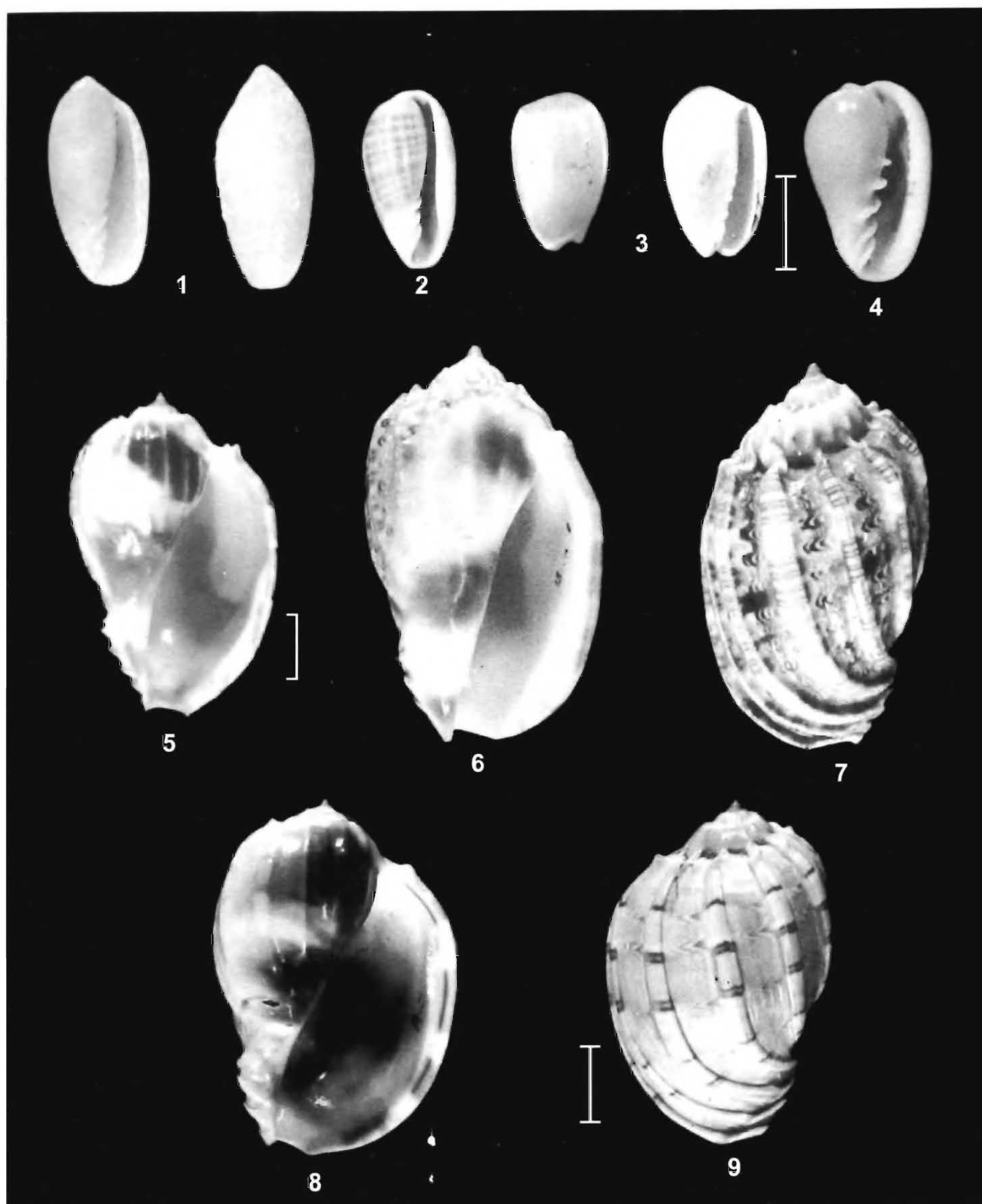
1, 2. *Oliva sidelia* : Visakhapatnam; 3, 4. *Oliva oliva*; 5. *Oliva sericea* : Visakhapatnam; 6, 7. *Amalda ampla* : Visakhapatnam; 8, 9. *Marginella loebeckeana* : Visakhapatnam; 10. *Marginella angustata* : Visakhapatnam.

Plate 72 : Olividae



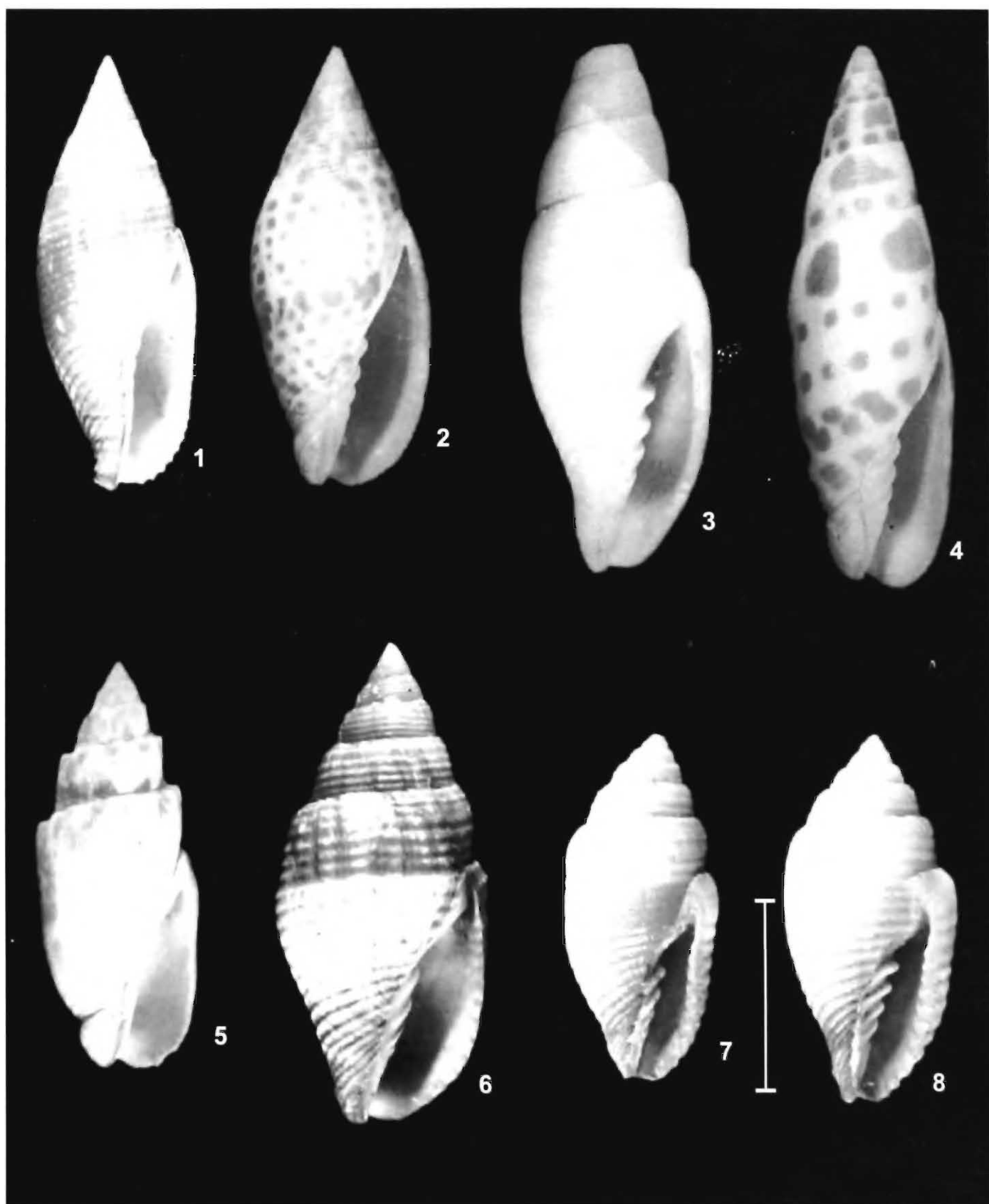
1. *Oliva vidua* : Andamans; 2. *Oliva sericea* : Andamans, M4139; 3. *Oliva miniacea*; 4. *Oliva oliva*;
 5. *Agaronia nebulosa* : Simbor, Diu, M 21744/4; 6,7. *Amalda ampla*; 8,9. *Oliva annulata*;
 10. *Olivancillaria gibbosa*; 10,11. *Ancilla monilifera*; 12,13. *Oliva caerulea*.

Plate 73 : Marginellidae, Harpidae



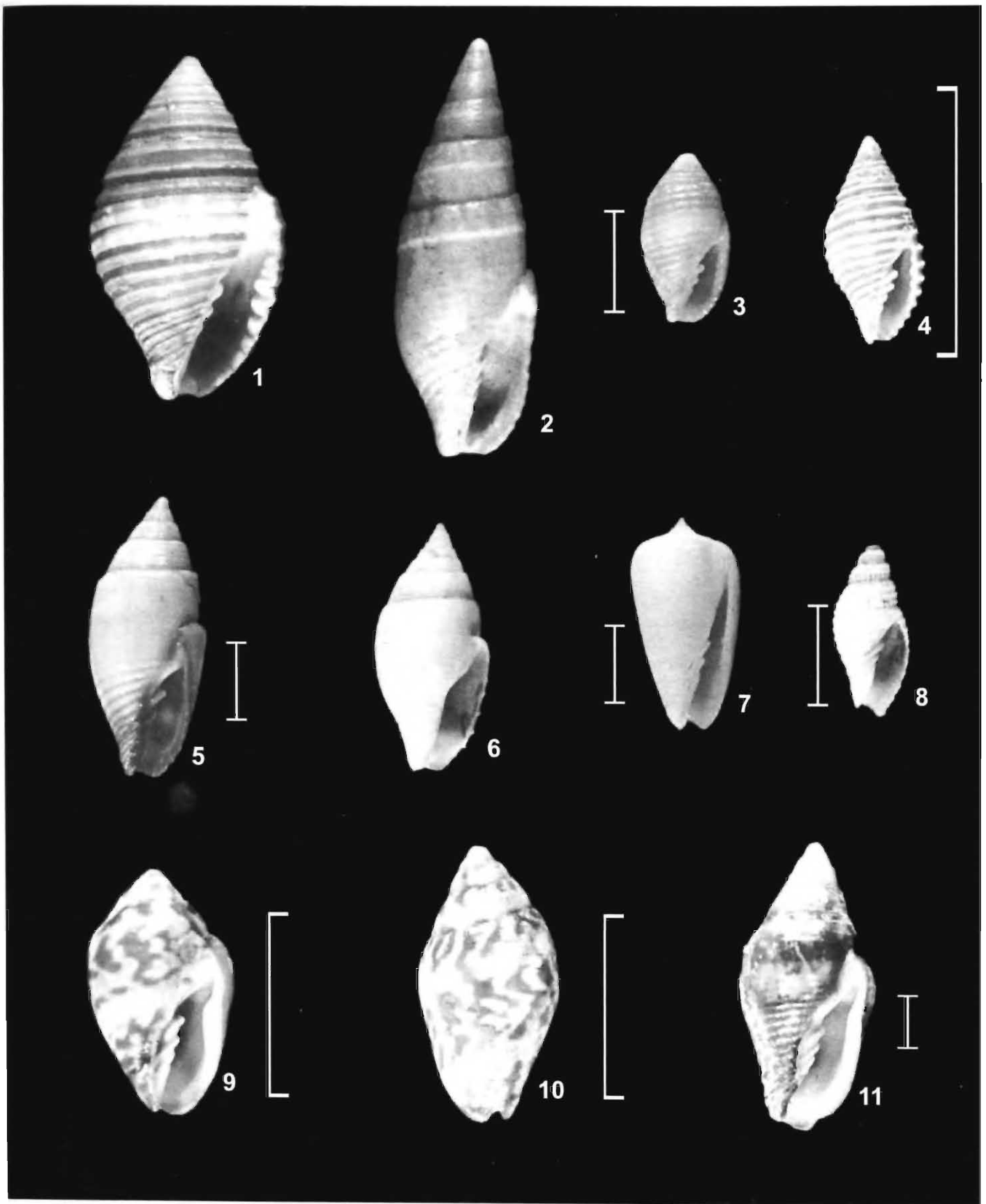
1a,b. *Persicula persica* : x 5; 2. *Marginella angustata* : Andamans, M 12362/2; 3 a,b. *Marginella ventricosa* : Gopalpur, Orissa, M23762; 4. *Marginella loebeckeana* : Pondicherry, M23706/5; 5. *Harpa davidis* : Paradip, Orissa, M 23800/5; 6,7. *Harpa amouretta* : Andamans, M4117; 8,9. *Harpa major* : Indian Ocean.

Plate 74 : Mitridae



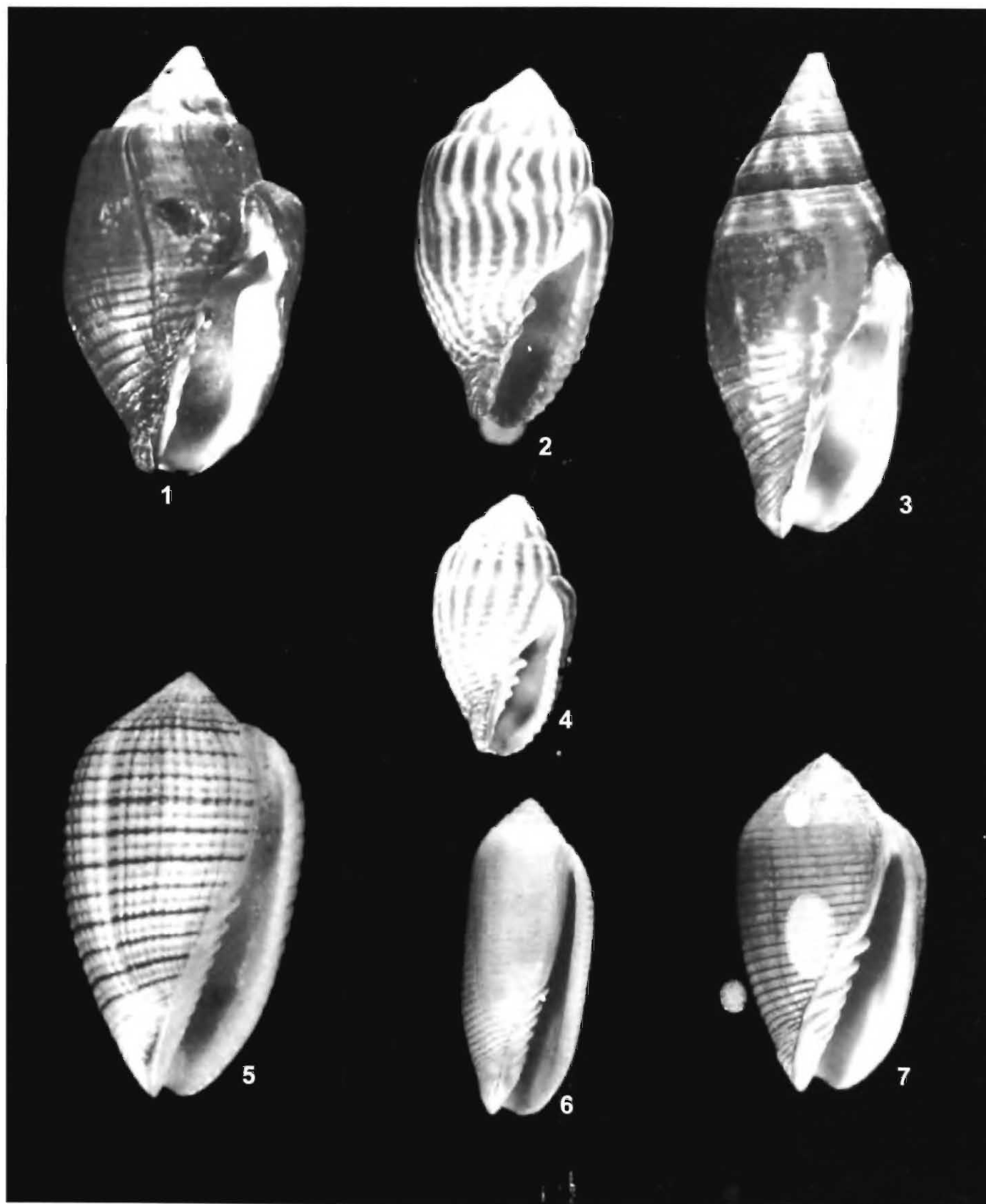
1. *Mitra ambigua*; 2. *Mitra cardinalis*; 3. *Mitra guttata*; 4. *Mitra mitra*; 5. *Mitra stictica*; 6. *Mitra (N.) aurantia subruppeli*; 7,8. *Mitra (Nebularia) aurantia aurantia*.

Plate 75 : Mitridae



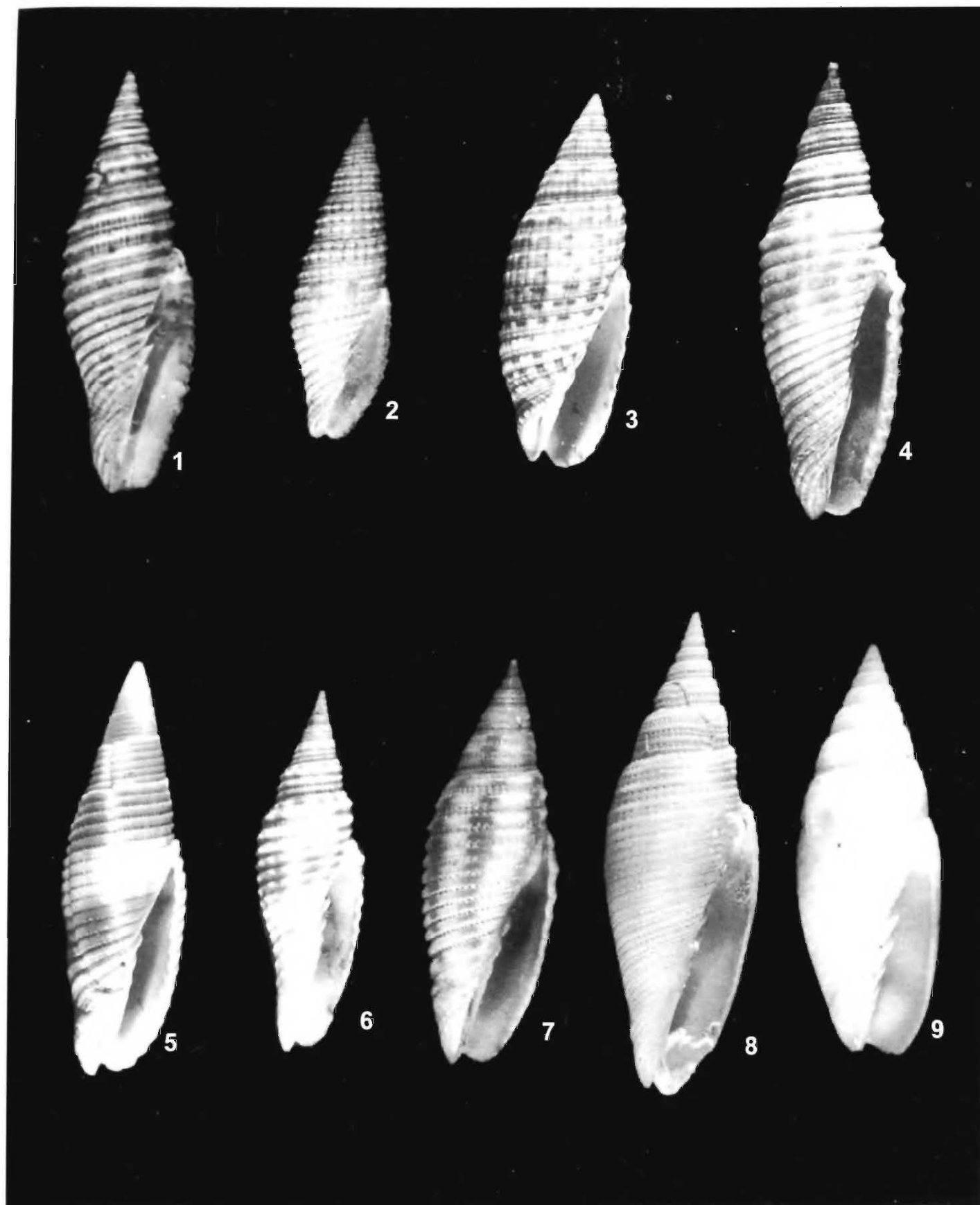
1. *Mitra (N.) cucumerina*; 2. *Mitra (N.) luctuosa*; 3. *Mitra (N.) chrysalis*; 4. *Mitra (N.) tabanula*;
 5,6. *Mitra (N.) ticaonica*; 7. *Imbricaria punctata* : x 8. *Scabricola fusca* : Puri, Orissa. 7x3mm;
 9,10. *M (Strigatella) litterata*; 11. *M (Strigatella) columbelliformis*.

Plate 76 : Mitridae



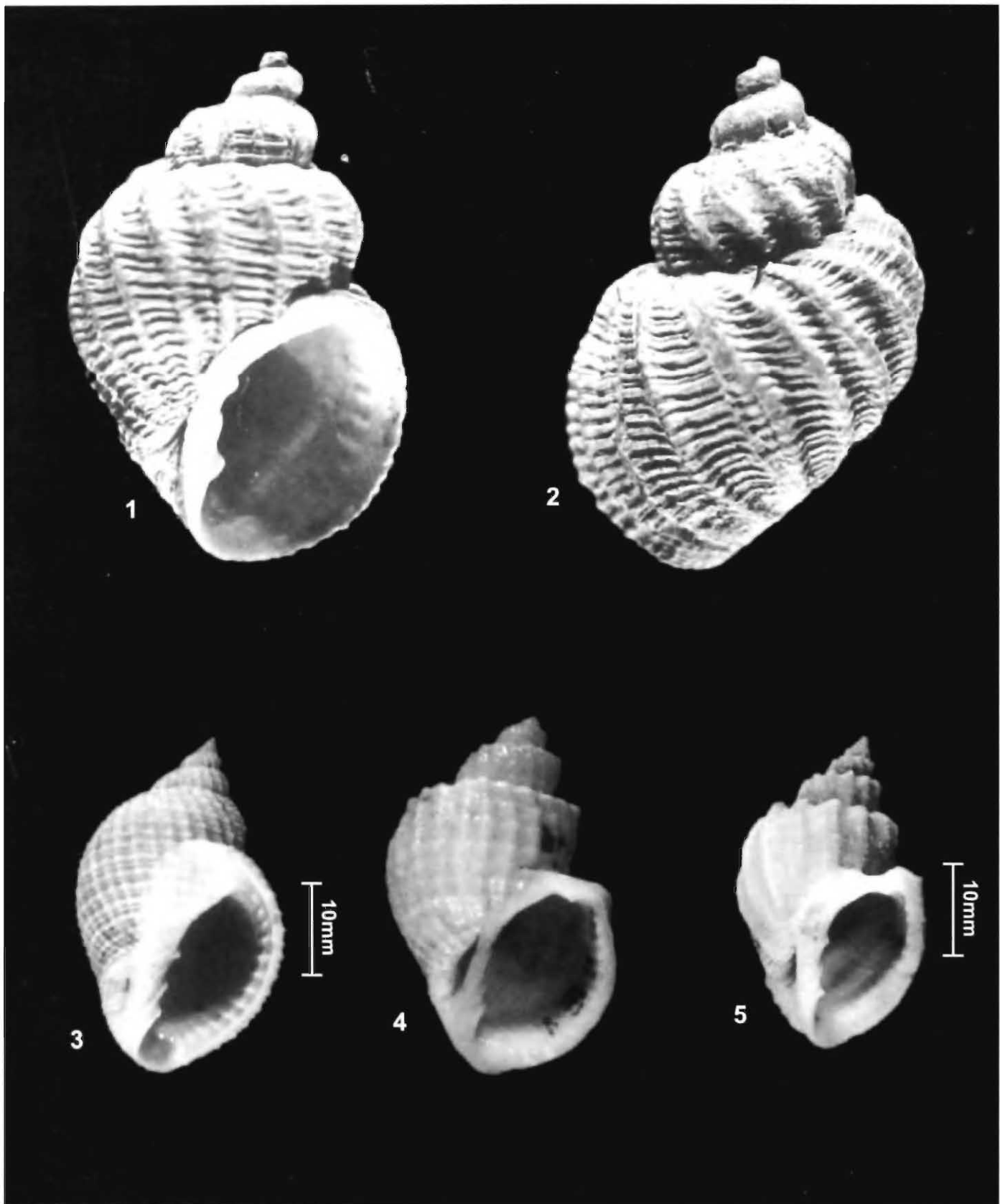
1. *M. (Strigatella) decurtata*; 2. *M. (Strigatella) paupercula*; 3. *M. (Strigatella) scutulata*; 4. *M. (Strigatella) retusa*; 5. *Pterygia crenulata*; 6. *Pterygia fei estrata*; 7. *Pterygia dactylus*.

Plate 77 : Mitridae



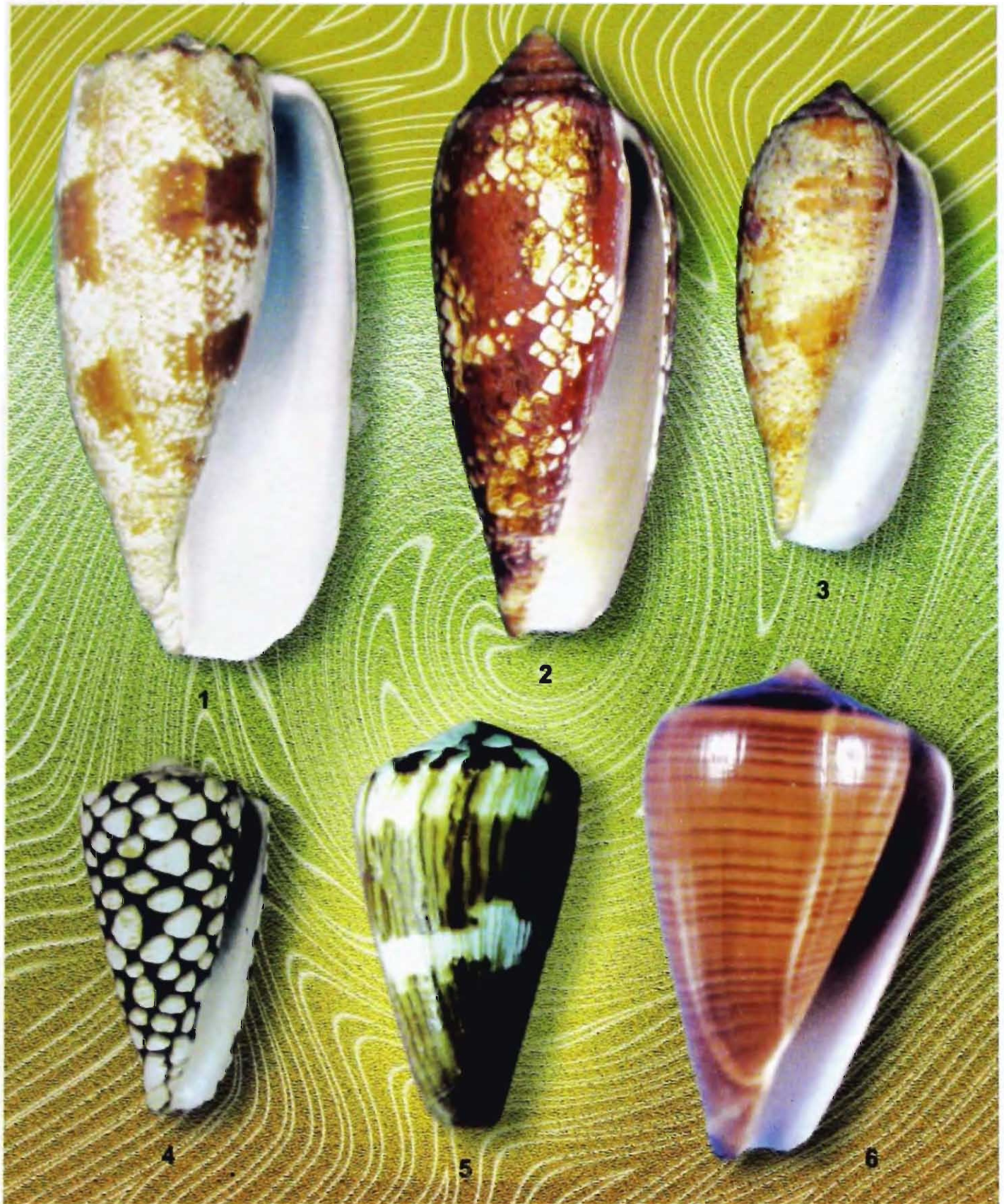
1. *Neocancilla circula*; 2. *Neocancilla granatina*; 3. *Neocancilla papilio*; 4. *Cancilla interlirata*;
5. *Cancilla Isabella*; 6. *Cancilla philippinarum*; 7. *Subcancilla flammea*; 8. *Domiporta rufilirata*
9. *Scabricola (Scabricola) caerulea*.

Plate 78 : Cancellariidae



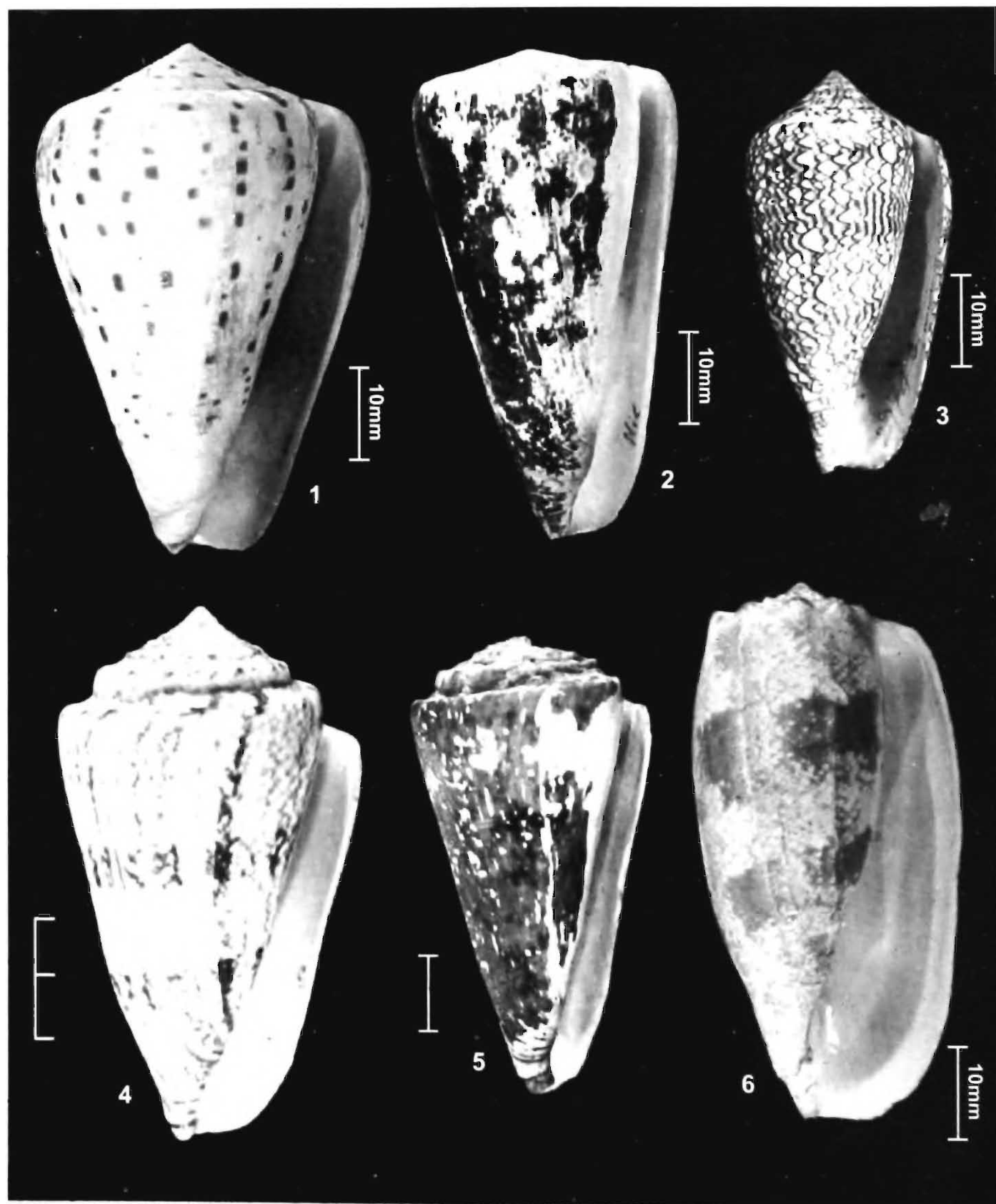
1,2. *Cancellaria quasilla*; 3. *Cancellaria asperella* : Andamans, M 3311. 4. *Trigonostoma scalata* : Andamans, M 1310; 5. *Trigonostoma scalariformes* : Andamans.

Plate 79 : Conidae



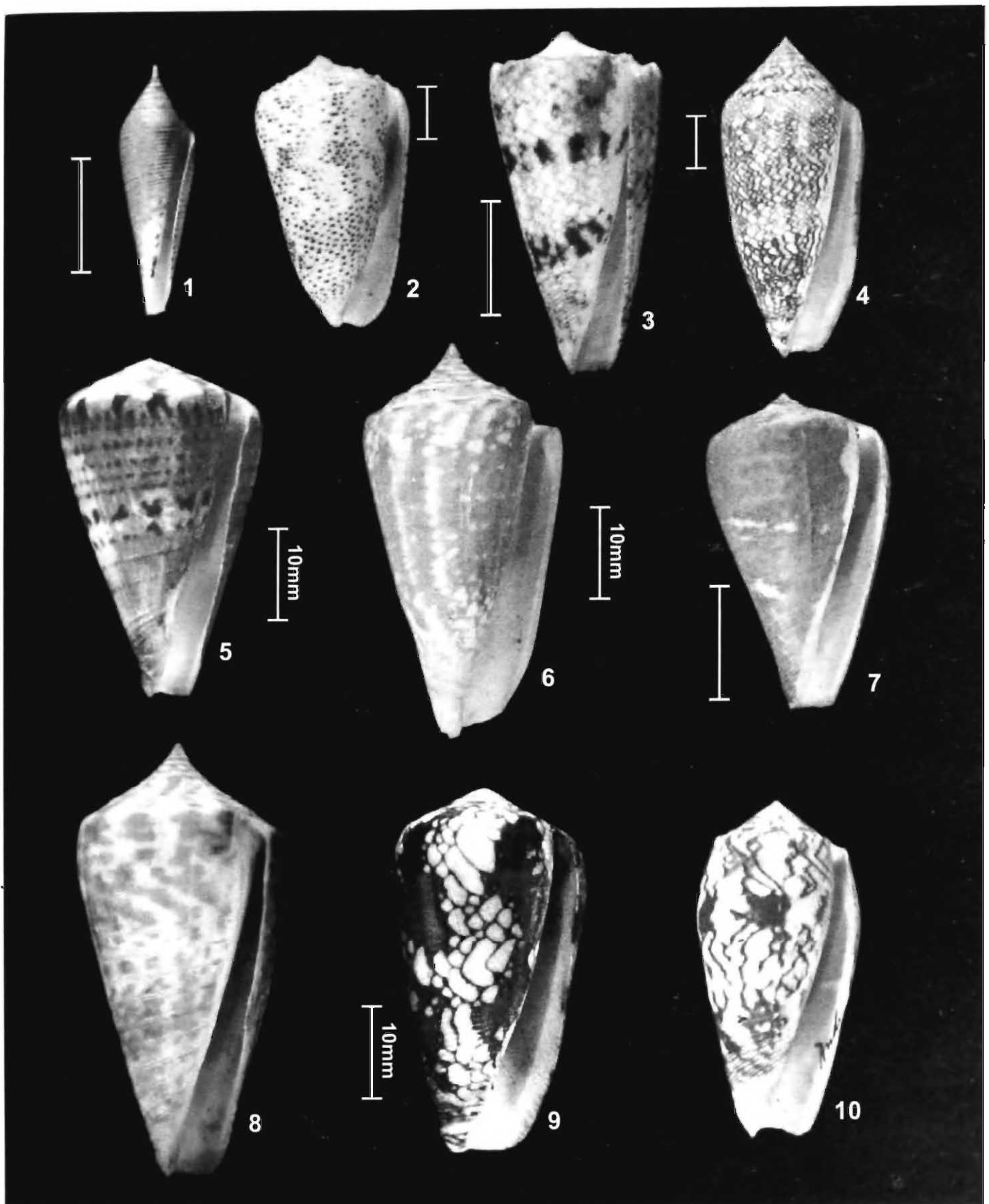
1. *Conus geographus*; 2. *Conus striatus*; 3. *Conus tulipa*; 4. *Conus marmoreus*; 5. *Conus vexillum*
6. *Conus figulinus*.

Plate 80 : Conidae



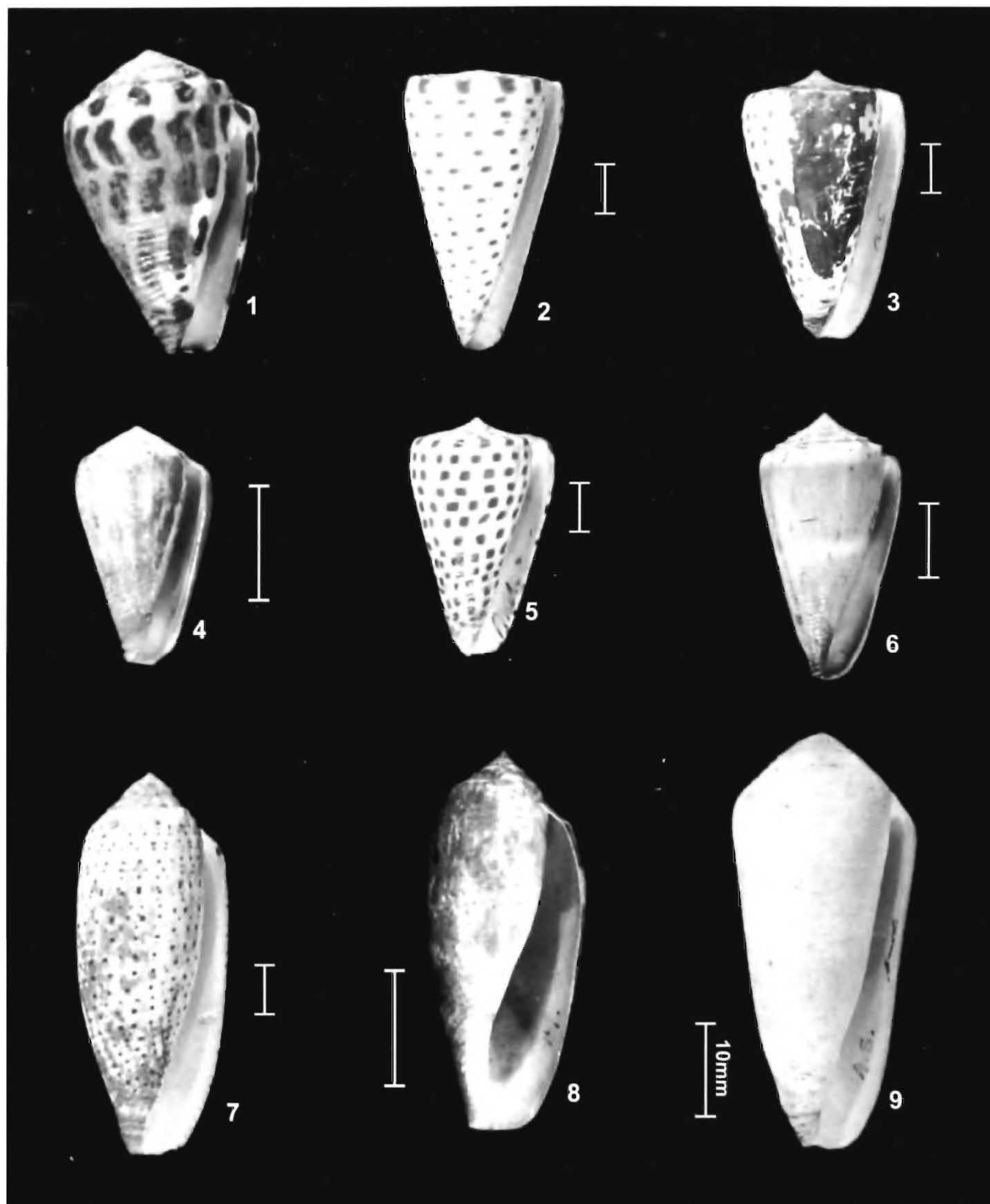
1. *Conus betulinus*; 2. *Conus virgo* : Nicobars; 3. *Conus textile* : Indian Seas; 4. *Conus araneosus*
5. *Conus distans* : Andamans; 6. *Conus geographus*.

Plate 81 : Conidae



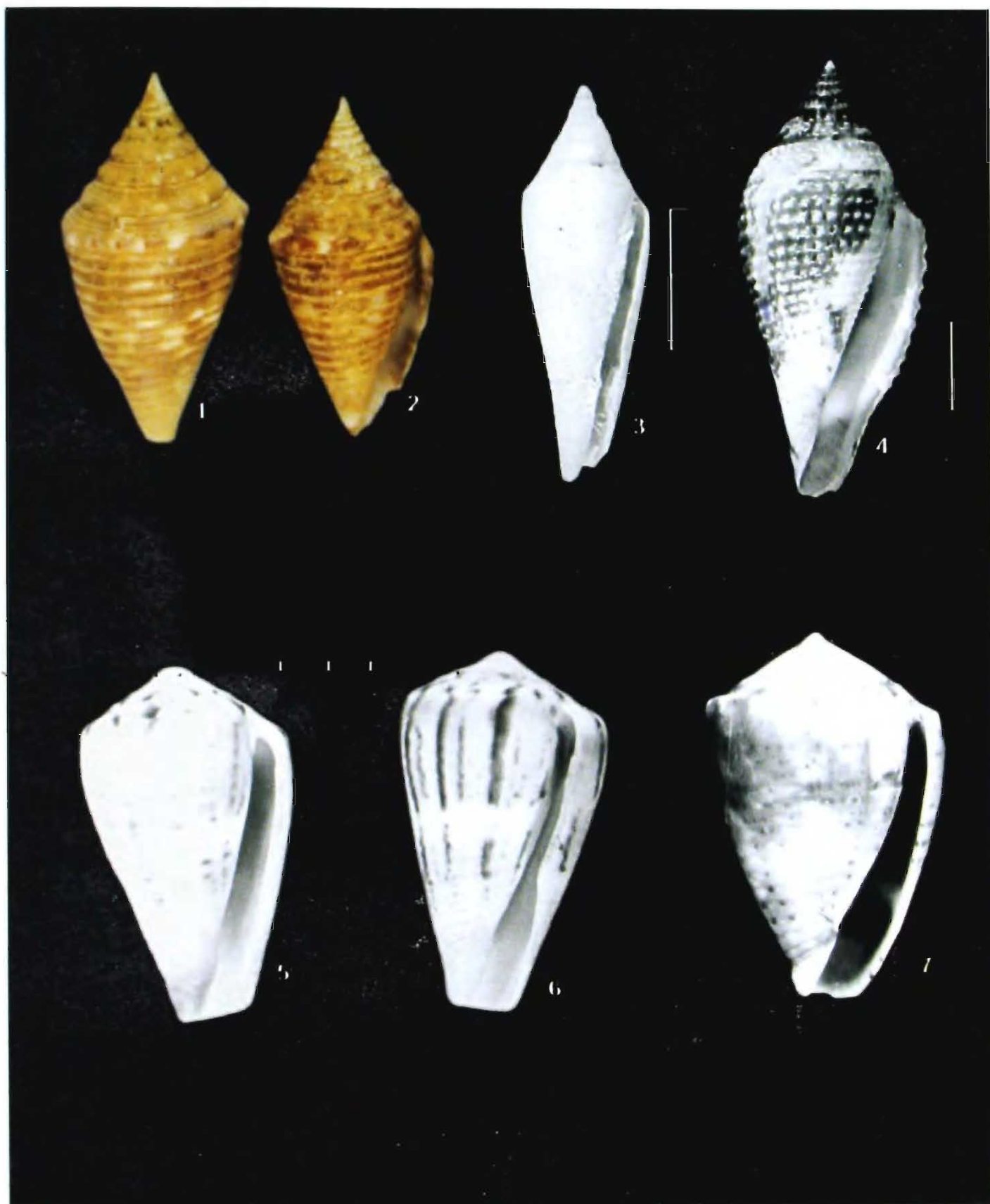
1. *Conus aculeiformis*; 2. *Conus arenatus*; 3. *Conus nicobaricus*; 4. *Conus canonicus*; 5. *Conus capitaneus*; 6. *Conus amadis*; 7. *Conus mutabilis*; 8. *Conus inscriptus*; 9. *Conus episcopus*; 10. *Conus striatus*.

Plate 82 : Conidae



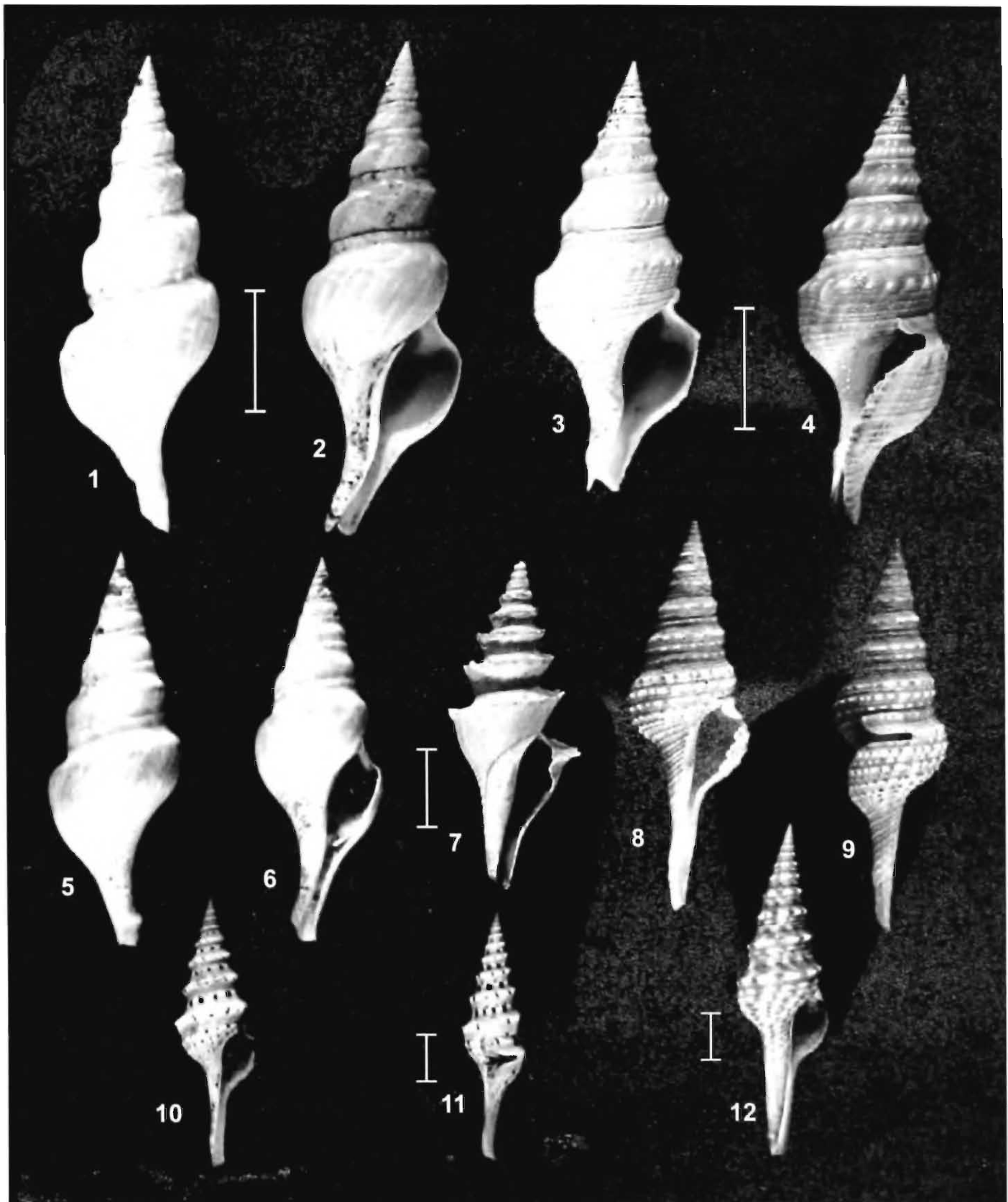
1. *Conus ebraeus*; 2. *Conus litteratus*; 3,5. *Conus eburneus*; 4. *Conus piperatus*; 6. *Conus lividus*; 7. *Conus nussatella*; 8. *Conus tulipa*; 9. *Conus terebra*.

Plate 83 : Conidae



1,2. *Conus acutangulus*; 3. *Conus coronatus*; 4. *Conus coromandelicus*; 5. *Conus elegans*; 6. *Conus figulinus* x.

Plate 84 : Turridae



1,2. *Turricula tornata tornata*; 3,4. *Turricula javana*; 5,6. *Turricula tornata fulminata* x;
7. *Cochlespira travancorica travancorica*; 8,9. *Turricula javana*; 10,11. *Lophiotoma acuta*;
12. *Lophiotoma indica*.

Family CONIDAE

Cones

Shell is small to large in size, often attaining a maximum height of 100 mm. It is solid, cone shaped and often heavy. Spire is generally depressed or low, pointed and in some may be highly elevated. Aperture is long and narrow extending along the whole length of the body whorl. Inner and outer lips run almost parallel to each other and the latter is smooth bearing no denticles. A distinct posterior sinus may exist. Surface of the shell is covered by thin or thick periostracum, which may be yellowish or brownish, often obscuring the actual colour of the shell. There is great variability in colour pattern but it is generally specific. Operculum with a terminal nucleus is usually present. It is small, ovate to elongate with an unguiform shape.

Cephalic region bears a tubular rostrum and a pair of tentacles bearing eyes on their distal outer surfaces. Foot is long and narrow. Mantle cavity consists of an incurrent siphon and a ctenidium. Proboscis is intraembolic or polyembolic. Radula is toxoglossate, generally with lateral teeth and rarely with a central. Marginal teeth are modified into harpoon-like structures with poison. Oesophagus does not bear any valve of Leiblein. Sexes are separate; a conspicuous tubular verge is present in the male. Females deposit eggs in pouch-like capsules and some are capable of depositing several thousand eggs at one sitting. Pelagic larvae emerge out of the capsules and can survive for variable durations.

The family includes about 500 recent species which are generally abundant in tropical coral reef habitats. Majority live in the intertidal zone between the reef and the shore, in the rock and coral crevices and in sandy habitats in the reef. These are carnivorous feeding on molluscs (molluscivorous), on worms (vermivorous) and small fishes (piscivorous). Cones are common in the Andaman and Nicobar Islands, Gulf of Mannar, Gulf of Kachchh and Lakshadweep. A few species were collected off the mainland coast of India from the intertidal sandy zone to a depth of about 40 m. About 73 species of Cones are known from India, and of these 53 are reported from Andaman and Nicobar Islands.

***Conus aculeiformis* Reeve, 1843**

(Pl. 81, fig. 1)

Shell small, up to 25 mm in height, spindle shaped with an elongate body whorl and an elevated spire, light, sculptured with round spiral ridges separated by minute beaded grooves, surface white, with quadrangular light brown markings.

India : Tamil Nadu : Madras, Tranquebar; Pondicherry, Andaman and Nicobar Islands, not common. Indo-Pacific, Red Sea to Philippines.

***Conus acutangulus* Lamarck, 1810**

(Pl. 83, fig. 1, 2)

Shell small, up to 25 mm in height, solid, sharply pointed at both ends, body whorl broad at the shoulder, spire high and pointed, about a third of the total height of the shell. Surface sculptured with spiral ridges and fine axial striations in the interstices, yellowish-brown, flecked with dark brown, often with indistinct, interrupted spiral bands, one above and the other below the centre, ridges decorated with widely spaced brown dots, spire with broad brown spots, aperture white.

India : Maharashtra : Bombay; Tamil Nadu : Madras, Coromandal Coast; Andhra Pradesh : Visakhapatnam, offshore, 51 to 83 m, not common. Tropical Indo-West Pacific, Red Sea to Hawaii.

***Conus amadis* Gmelin, 1791**

(Pl. 81, fig. 6)

Shell of medium to large size, up to 85 mm in height, light weight, spire sharp and pointed, shoulder often channelled, spire and base of body whorl with spiral grooves, colour highly variable, white with orange brown reticulations which often join into irregular bands, spire decorated with large brown spots, aperture white, periostracum absent in preserved specimens.

India : Tamil Nadu : Gulf of Mannar, Coromandal Coast, Porto Novo; Andaman and Nicobar Islands. Sri Lanka to North Sumatra.

Coomans *et al.* (1980) recognized two subspecies, *Conus amadis amadis* occurring in Sri Lanka and Coromandel coast, and *Conus amadis castaenofasciatus* Dautzenberg, 1937 occurring around Andaman and Nicobar Islands.

***Conus araneosus* Solander in Lightfoot, 1786**

(Pl. 80, fig. 4)

Shell moderately large, up to 60 mm in height, solid and heavy, spire slightly elevated with a blunt apex, body whorl with an angulated shoulder, spire whorls coronated with raised tubercles, yellowish white or light chocolate brown with dark brown triangular marks, encircled with two or three interrupted or irregular but well defined bands of chocolate brown, in some the top most band broader than the lower ones, often the upper two bands coalesce together forming a broader band, aperture white.

India : Tamil Nadu : Coromondal Coast, Gulf of Mannar; Andaman and Nicobar Islands, common, intertidal to a little subtidal on limestone or sand substrates. Indian Ocean.

It breeds during October-March in the Gulf of Mannar (Natarajan, 1957).

Synonym : *Conus arachnoideus* Gmelin, 1791 (Coomans *et al.*, 1981).

***Conus arenatus* Hwass in Bruguiere, 1792**

(Pl. 81, fig. 2)

Shell of medium size, up to 50 mm in height, heavy, stoutly turbate or cylindrical, spire convexly flat or slightly elevated, body whorl a little inflated and strongly coronated at the shoulder, columella with a plait or fold. Colour white decorated with closely spaced numerous small reddish-brown dots all over, some arranged in two or three dark bands, aperture white.

India : Maharashtra, Lakshadweep, Tamil Nadu, Andaman and Nicobar Islands. Tropical Indo-Pacific, from India to Tuamotu Archipelago and from South Japan to North Australia (Coomans *et al.*, 1981).

***Conus aulicus* Linnaeus, 1758**

(Pl. 79, fig. 5)

Shell large, up to 80 mm in height, solid and inflated, spire pointed. Surface beautifully coloured with large white tent marks on a dark brown background.

India : Andaman & Nicobar Islands. Indo-Pacific.

At a first glance the species bears some resemblance to *C. episcopus* but differs from it in being narrow and being smoother.

***Conus betulinus* Linnaeus, 1758**

(Pl. 80, fig. 1)

Shell large, up to 95 mm in height, heavy, spire not much elevated, body whorl inflated with rounded shoulder, surface smooth except for a few spiral ridges at the base, creamy yellow, ornamented with widely spaced spiral rows of dark brown spots of variable sizes, aperture creamy white with yellow-edged lip, periostracum thick and yellowish.

India : Orissa : Gopalpur; Andhra Pradesh : Visakhapatnam; Tamil Nadu : Madras, Tuticorin, Porto Novo, Tranquebar; Pondicherry, common. It is collected in trawl nets at about 20 to 25 m depth. Indo-West Pacific.

***Conus capitaneus* Linnaeus, 1758**

(Pl. 80, fig. 6)

Shell moderately large, up to 60 mm in height, spire low and striate, colour brownish with yellow or green tinge, ornamented with lines of black spots encircling the body whorl above the central white band and bordering it below, purple base devoid of spots, white band on body

whorl and its shoulder, spire with black and white chequered effect extending a little on to the shoulder below.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-West Pacific.

***Corus coromandelicus* (E. A. Smith, 1894)**

(Pl. 63, fig.1)

Shell of medium size, up to 35 mm in height, light but solid, almost biconic, resembles a cone shell, spire small. Aperture twice as long as spire, columella without callus, outer lip thin and corrugated, posterior sinus shallow and at the tip of the outer lip, siphonal canal broad and truncated, spire whorls slightly keeled with incised sutures. Sculptured with strong, regular, sometimes nodulose spiral ribs, shoulder of each whorl with axial striae. Colour pale brown, ribs darker, aperture white.

India: Bay of Bengal, 200 m. Elsewhere: Gulf of Arabia.

***Conus coronatus* Gmelin, 1791**

(Pl. 64, fig. 5–7)

Shell of medium size, up to 40 mm in height, solid and stout, spire elevated with an obtuse and blunt apex, body whorl with an angulated and coronated shoulder, surface with several small, threadlike spiral ridges marked with alternate white and brown, colour grayish blue, encircled with two bluish gray bands, a broader one on the top and a narrower one at the base, interrupted by white and zigzag axial lines, spire whorls with spiral bands of white and brown, aperture purplish brown, periostracum thin and brownish yellow.

India : Gujarat : Okha; Tamil Nadu : Gulf of Mannar (Krusadai and Shingle Islands), Mandapam, Andaman and Nicobar Islands. Widely distributed in the Indo-West Pacific.

***Conus distans* Hwass in Bruguiere, 1792**

(Pl. 80, fig. 5)

Shell large, up to 100 mm in height, elongately turbinated, narrow in the middle, spire convexly exerted, apex characteristically and flatly truncated, shoulder coronated with obtuse white knobs and yellowish brown interstices, light brown with a broad paler band at the centre, base stained with blackish violet.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-West Pacific.

***Conus ebraeus* Linnaeus, 1758**

(Pl. 82, fig. 1)

Shell of medium size, up to 50 mm in height, spire moderately elevated and coronated, colour brownish- white, three or rarely four broad spiral bands of dark chocolate or black chevron-shaped or rhomboid markings, spire and top ornamented with black markings, surface more or less striated throughout but more prominent towards the dark stained base, aperture white, periostracum thin and translucent.

India : Lakshadweep, Tamil Nadu : Gulf of Mannar; Pondicherry, Andaman and Nicobar Islands. Indo-West Pacific to Central America.

Common on the beach rock exposed during low tide and in areas where polychaetes are abundant.

***Conus eburneus* Hwass in Bruguiere, 1792**

(Pl. 82, fig. 3, 5)

Shell moderately large, up to 70 mm in height, heavy with rounded shoulders and flattened top, spire small and pointed, colour white with regularly arranged spiral rows of black or dark brown quadrangular spots, periostracum olive brown and translucent.

India : Lakshadweep (not common), Tamil Nadu : Tuticorin, Tranquebar; Andhra Pradesh : Visakhapatnam (25 m); Andaman and Nicobar Islands. Widely distributed in the Indo-West Pacific.

***Conus elegans* Sowerby, 1895**

(Pl. 83, fig. 3)

Shell of medium size, up to 35 mm in height, thin, glossy, spire elevated, with pointed nodules above sutures, protoconch glossy and pointed, surface with distinct spiral grooves at the lower half, white with spiral rows of reddish brown blotches or dots.

India : Andhra Pradesh: Visakhapatnam. Indian Ocean.

***Conus episcopus* Hwass in Bruguiere**

(Pl. 79, fig. 11)

Shell small, up to 40 mm in length, spire highly elevated with blunt apex. Surface smooth except for spiral threads on the base of the body whorl, ornamented with white tent marks on brown background colour.

The shell looks similar to that of *Conus textile* but it is narrower and less glossy.

India : Lakshadweep, Andaman and Nicobar Islands, not common. Indo-Pacific.

***Conus figulinus* Linnaeus, 1758**

(Pl. 79, fig. 6)

Shell moderately large, up to 71 mm in height, heavy, pyriform with elevated spire, colour uniformly light brown encircled with many dark brown spiral lines, a pale tan band at shoulder, spire dark brown, aperture white, periostracum thick and dark brown.

India : Maharashtra : Bombay; Kerala : Malabar Coast; Tamil Nadu : Madras, Gulf of Mannar; Pondicherry.

***Conus flavidus* Lamarck, 1810**

(Pl. 79, fig. 3)

Shell relatively smaller than in other cones, up to 60 mm in height, spire flat, surface smooth except for a few spiral striations at the anterior end. Aperture narrow, outer lip thin. Colour yellowish-brown becoming pale on the shoulder and spire, a narrow white band at the middle of the body whorl. Interior of aperture purple coloured.

India. Indo-Pacific.

***Conus geographus* Linnaeus, 1758**

(Pl. 79, fig. 12 and Pl. 80, fig. 6)

Shell large, up to 110 mm in height, thin and light weight, spire short with coronated whorls, body whorl ovately cylindrical with widely spaced coronations at the shoulder, surface smooth, columella with a thick callus at the base, colour brownish with some white tent marks and blotches, darker brown blotches, often with two broken spiral bands, aperture white.

It has a poisonous sting whose bite may be fatal to man and hence the specimen should be handled carefully in the field.

India : Tamil Nadu : Gulf of Mannar; Pondicherry; Andaman and Nicobar Islands, not common. Indo-West Pacific, intertidal sands.

***Conus inscriptus* Reeve, 1843**

(Pl. 81, fig. 8)

Shell small, up to 40 mm in length, spire pointed. Body whorl white, ornamented with brownish yellow spots, aperture white.

India : Maharashtra : off Bombay, 82 m; off Ratnagiri 50 m. Kerala : off Calicut, 82 m. Tamil Nadu : Cape Comrin, Porto Novo, Madras (46 and 64 m) : From Red Sea to Bay of Bengal (Kohn, 1978).

Conus litteratus Linnaeus, 1758

(Pl. 79, fig. 8 and Pl. 82, fig. 2)

Shell very large, up to 142 mm in height, with a flat spire and rounded shoulder, white with a number of rows of close-set bands of rectangular dark chocolate or black spots, the spots sometimes elongated axially towards the shoulder, usually encircled with two to three broad indistinct light yellow or orange-brown bands, often covered with brownish periostracum.

India : Lakshadweep, Andaman and Nicobar Islands. Tropical Indo-Pacific.

It occurs partly buried in sand in knee-deep water.

Conus lividus Hwass in Bruguiere, 1792

(Pl. 82, fig. 6)

Shell of medium size, up to 50 mm in height, heavy, spire depressed and conical, surface spirally striated, striae at the base often granulose, spire and shoulder coronated with tubercles, colour livid green with a white band around the middle of the body whorl, spire white with a purple apex, interior of aperture deeply stained with yellow at the upper and lower parts.

India : Tamil Nadu : Tranquebar, Gulf of Mannar (Shingle Island); Pondicherry, (very rare), Andaman and Nicobar Islands (common).

It bears striking similarity to *Conus flavidus* Lamarck, 1850 but differs from it in having coronations on the spire and shoulder.

Conus marmoreus Linnaeus, 1758

(Pl. 79, fig. 2)

Shell large, up to 90 mm in height, thick and solid, obconical shape, spire flat. Aperture narrow with a thin outer lip. Sculptured with widely spaced nodules on the shoulder. Coloured with triangular white patches on dark brown back ground. Periostracum thin and transparent.

India : Tamil Nadu : Madras, Gulf of Mannar (Pamban); Andaman Islands. Uncommon. Indo-Pacific.

Conus miles Linnaeus, 1758

(Pl. 79, fig. 1)

Shell large, up to 90 mm in height, heavy, broadly conical, spire flatly obtuse with blunt apex, shoulder lightly keeled, pale yellowish, ornamented with fine, wavy, axial light brown

lines, two dark spiral bands, one slightly above the middle region and another at the base of the body whorl, aperture white with two brown zones.

India : Andaman and Nicobar Islands. Tropical Indo-West Pacific.

It occurs in sandy patches among coral reefs where a little water remains even during low tide.

***Conus mutabilis* Reeve, 1844**

(Pl. 81, fig. 7)

Shell of medium size, up to 50 mm in height, solid and broadly conical, spire elevated with pointed apex, body whorl with light to dark brown axial flammules, extending to dark brown, with interrupted darker spiral lines, spire tan or white, with dark brown axial flammules, extending on to the body whorl, aperture white.

India : Maharashtra : Bombay; Goa, Karnataka : Karwar; Tamil Nadu. Elsewhere : Sri Lanka, Borneo, Hong Kong.

***Conus nicobaricus* Hwass in Bruguiere, 1792**

(Pl. 81, fig. 3)

Shell large, up to 100 mm in length, thick and heavy, spire elevated, body whorl sharply angulated above, spire with distinct coronations. Coloured with brown lines on white background and ornamented with two prominent spiral bands of dark brown mottlings.

India : Andamans. Mainly Pacific, Indonesia to Phillippines.

The shell is similar to that of *Conus araneosus*. Many consider this as a subspecies of *C. araneosus*.

***Conus nussatella* Linnaeus, 1758**

(Pl. 82, fig. 7)

Shell of medium size, up to 50 mm in height, glossy, elongate cylindrical, spire elevated, with pointed apex, shoulder steeply sloping, surface of body whorl sculptured with low spiral ridges, finer spiral ridges above the shoulder, white with irregular orange brown to light purplish brown blotches, spiral ridges ornamented with dark brown spots, aperture white, periostracum smooth and translucent.

India : Gujarat : Okha; Tamil Nadu : Madras, Gulf of Mannar (Shingle Island). Tropical Indo-West Pacific.

Conus piperatus Dillwyn, 1817

(Pl. 65, fig. 8)

Shell of medium size, up to 40 mm in height, spire elevated, spire and shoulder of the body whorl with obsolete coronations, colour light bluish-gray with an obsolete pale brown band and a violet anterior region, dark brown spots in between coronations.

India : Andamans, rare. Indian Ocean.

Conus striatus Hwass in Bruguiere, 1792

(Pl. 81, fig. 10)

Shell large, up to 100 mm in height, thick, cylindrically turbate with short and obtusely convex spire, tapered shoulder, surface of the body whorl sculptured with fine spiral striations, spire whorls channelled, colour pinkish-white with blotches of purple gray or brown, spire white with rose-tainted apex, aperture white.

India : Tamil Nadu : Gulf of Mannar (Tuticorin, Hare Island, Krusadai Island, Shingle Island); Andaman and Nicobar Islands. Tropical Indo-West Pacific.

It has a poisonous sting and should be handled carefully while collecting in the field.

Conus terebra Born, 1798

(Pl. 82, fig. 9)

Shell large, up to 90 mm in height, heavy and narrow, sculptured with coarse spiral ridges, colour white with two pale yellow bands, one on the shoulder and the other a little below middle of the body whorl, base tinged with purple at the to, purple lines below sutures, aperture white, periostracum thick and brown.

India : Tamil Nadu : Madras, Gulf of Mannar (Krusadai Island); Andaman and Nicobar Islands (not common).

Conus textile Linnaeus, 1752

(Pl. 79, fig. 6 and Pl. 80, fig. 3)

Shell large, up to 90 mm in height, glossy, cylindrically ovate, spire acuminate, body whorl strongly shouldered and narrow towards the base, surface smooth or with weak spiral striations at the base, colour yellowish white or golden yellow, with large irregular, orange brown maculations, often arranged in two or three reddish brown interrupted spiral bands, aperture white, periostracum thin and smooth.

India : Tamil Nadu : Madras, Gulf of Mannar (Tuticorin); Pondicherry, Andaman and Nicobar Islands, not common. Tropical Indo-West Pacific.

It is venomous and should be handled carefully in the field.

***Conus tulipa* Linnaeus, 1758**

(Pl. 79, fig. 9, 10 and Pl. 82, fig. 8)

Shell moderately large, up to 60 mm in height, thin and swollen, spire elevated and faintly coronated, body whorl with a distinct shoulder, lower half of aperture wide, colour sky blue with clouds of dark brown ornamented with spiral lines of tiny brown dots.

India : Andamans. Andamans to Australia and Central Pacific.

It bears some similarity to *C. nussatella* but can be easily distinguished by its swollen shell and wider lower half of aperture and dark brown maculations on the body whorl.

***Conus vexillum* Gmelin, 1791**

(Pl. 79, fig. 4)

Shell large, up to 75 mm in height, rather thick and solid, spire flat, biconical, body whorl shouldered. Aperture elongate and narrow. Surface without any sculpture. Colour reddish-brown with two whitish bands one just below the suture and the other at the middle of the body whorl.

India : Tamil Nadu : Gulf of Mannar (Tuticorin); Andaman & Nicobar Islands. Indo-Pacific.

***Conus virgo* Linnaeus, 1758**

(Pl. 80, fig. 2)

Shell large, up to 80 mm in height, heavy, spire short or flat topped, shoulder low, conical and sharply keeled, sides almost straight, widely spaced weak spiral ridges at the base, fine spiral threads on spire whorls, colour white to pale yellow, tinged with deep bluish violet at the base, aperture white with deep bluish violet tinge at the lower end, periostracum thick and brown.

India : Tamil Nadu : Gulf of Mannar (Mandapam, Tuticorin); Pondicherry. Andaman Islands.

A Checklist of the species of *Conus* in India.

The following species of *Conus* were also reported from Indian localities but are not included in this book, as the specimens are either not available for study or in not good condition.

1. *Conus achatinus* Gmelin, 1791
2. *C. andamanensis* E.A. Smith, 1878 Andamans (= *Conus collisus* Reeve, 1849)
3. *C. australis* Holten, 1802
4. *C. bandanus* Hwass in Bruguiere, 1792
5. *C. bayani* Jousseaume, 1872
6. *C. biliosus* (Roeding, 1798) Andaman and Nicobar Islands
7. *C. boschi* Clover, 1972
8. *C. characteristicus* Fischer, 1807 Andamans
9. *C. catus* Hwass in Bruguiere, 1792 Tamil Nadu, Andamans
10. *C. ceylanensis* Hwass in Bruguiere, 1792 Tamil Nadu, Andamans
11. *C. chaldeus* (Roeding, 1798) Andaman and Nicobar Islands
12. *C. edwardi* Preston, 1908 Andamans
13. *C. eximius* Reeve, 1849
14. *C. flavidus* Lamarck Andamans
15. *C. frigidus* Reeve, 1848
16. *C. generalis* Linnaeus Andamans
17. *C. glans* Hwass in Bruguiere, 1792 Nicobars
18. *C. gubernator* Hwass in Bruguiere, 1792
19. *C. insculptus* Kiener
20. *C. janus* Hwass in Bruguiere, 1792
21. *C. lentiginosus* Reeve, 1844
22. *C. longurionis* Kiener, 1849-50
23. *C. malaccanus* Hwass in Bruguiere, 1792
24. *C. masoni* G. & H. Nevill, 1874
25. *C. miliaris* Hwass in Bruguiere, 1792 Andamans
26. *C. millepunctatus* Lamarck

27. *C. milneedwardsi* Jousseaume, 1894
28. *C. monile* Hwass in Bruguiere, 1792 Andamans
29. *C. musicus* Hwass in Bruguiere, 1792
30. *C. nobilis* Linnaeus, 1758 Andamans
31. *C. pennaceus* Born, 1778 Andaman and Nicobar Islands
32. *C. pretiosus* G. & H. Nevill, 1874
33. *C. quercinus* Solander (in Lightfoot), 1706
34. *C. rattus* Hwass in Bruguiere, 1792
35. *C. straturatus* Sowerby
36. *C. striatellus* Link, 1807
37. *C. sulcatus* Hwass in Bruguiere, 1792
38. *C. tessulatus* Born, 1778 Kerala, Tamil Nadu, Andamans
39. *C. zeylanicus* Gmelin, 1791
40. *C. zonatus* Hwass in Bruguiere, 1792 Andaman and Nicobar Islands

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Family TURRIDAE

Shell is of minute to very large size, 1mm to 170 mm in height. It has variable shapes but generally fusiform with turret-shaped spire. Protoconch may be smooth or elaborately sculptured. Anterior siphonal canal may be very long and narrow or short and truncate. Columella usually is smooth or rarely nodulose or indistinctly plicate. Anal sinus is in the form of an indistinct slit to a deep profound turrid notch situated at various distances between the sutures and periphery on the outer lip. Sculpture is highly variable. It may consist of spiral cords, nodules, gemmules or spines. Operculum is corneous and small, which may be leaf-shaped or lanceolate with a terminal nucleus, or ovate to subovate with a medio-lateral nucleus. It may be often vestigial or absent.

Cephalic tentacles are widely separated bearing eyes at their bases. Proboscis is long and intraembolic or polyembolic. There are no jaws, but a poisonous venom gland is present. Radula may be more or less rachiglossate and nondetachable or toxoglossate with only marginals and detachable. There is no valve of Leibelin. Sexes are separate.

It is a large family divided into 15 subfamilies consisting of 600 genera and subgenera and about 2000 species. These are carnivorous and use a dart-like tooth to harpoon and capture the prey. These occur in shallow water to deep seas, majority being off shore forms.

There is not much work on Indian turrids. About 80 species were reported in Indian waters, but there may be many more species. The collection available for study included only 23 species, which are dealt here.

Subfamily TURRICULINAE

Turricula javana Linnaeus, 1767

(Pl. 84, fig. 8, 9)

Shell large, up to 75 mm in height, spire high, slightly shorter than the body whorl, aperture broad, with a wide posterior sinus extending from shoulder to suture, siphonal canal short and often twisted. Sculptured with obliquely set and axially elongate nodules on the shoulder, two narrow spiral ridges below suture, strong spiral threads on the lower half of the body whorl from shoulder to the base of siphonal canal. Colour brownish yellow with nodules being lighter.

India : Maharashtra: Bombay; Pondicherry, not common. Indian Ocean.

Turricula tornata tornata (Dillwyn, 1817)

(Pl. 84, fig. 1, 2)

Shell large, up to 90 mm in height, solid and heavy, fusiform, spire less than half the total length, sutures shallow, aperture wide, posterior sinus deep, siphonal canal long and twisted. Shell surface smooth, except for a shallow spiral ridge below the suture and spiral striations at the base of the body whorl. Colour creamy white ornamented with brown lines.

India : Maharashtra : Bombay; Tamil Nadu : Madras; Andhra Pradesh : Bheemunipatnam, Visakhapatnam; Orissa : Puri. India to Thailand.

Turricula tornata fulminata (Kiener, 1839-40)

(Pl. 84, fig. 5, 6)

Shell moderately large, up to 55 mm in height, similar to *T. tornata tornata* but differs from it in having a heavy subsutural fold, rounded shoulders, and more clear cut colour pattern of retractive reddish brown flames.

India : Gujarat : Gulf of Kachchh; Maharashtra : Bombay; Goa, Karnataka : Karwar; Lakshadweep, Pondicherry, Orissa, not common. Indian Ocean.

Cochlespira travancorica travancorica (E.A. Smith, 1896)

(Pl. 84, fig. 7)

Shell of medium size, up to 35 mm in height, thin and delicate, spire high, half the total length, aperture narrow, columella with callus, smooth, posterior sinus indistinct, anterior canal broad and short. Shoulders prominently keeled, with numerous, small, sharp spines, surface smooth, with a few spiral threads at the base of the body whorl. Colour uniformly dull white and devoid of ornamentation.

India : Kerala, Andamans (750 m). Indian Ocean.

Paradrillia fugata (E. A. Smith, 1895)

(Pl. 86, fig. 10)

Shell small, up to 32 mm in height and 11 mm in width, solid, spire a little less than half the total height of the shell, sutures shallow. Aperture narrowly elongate, columellar lip almost straight, siphonal canal broad and shallow, posterior notch small. Sculptured with raised axial ridges and obsolete spiral striae. Colour brownish with light brown aperture.

India : Off shore form. Investigator, Sta. 202-Bay of Bengal (7°4'40" N 80°25'30" E), 695 fms, Sta. 222-Andaman Sea (13°21' N 93°14'30" E), 1405 fms.

Subfamily TURRINAE

Lophiotoma acuta (Perry, 1811)

(Pl. 84, fig. 10, 11)

Shell of medium size, up to 45 mm in height, fusiform, spire long, more than half the total height, aperture narrow, outer lip with a prominent posterior slit, columella smooth, siphonal canal straight and of moderate length. Sculptured with prominent sharp double keel at periphery of each whorl, with three to four spiral threads on either side of the keel, sutures deep with moderately large ridges on either side. Colour white, speckled with small dark brown dots, most prominent on the keel, but with smaller dots on lesser ridges and threads, aperture dull white.

India : Andamans, common. Indo-Pacific, Red Sea to Samoa.

Synonym : *Pleurotoma tigrina* Lamarck, 1822

Lophiotoma indica (Roeding, 1798)

(Pl. 84, fig. 12)

Shell moderately large, up to 60 mm in height, elongate fusiform, spire long, less than half the total height, aperture narrow, with smooth columella and a deep, broad posterior slit on the outer lip. Siphonal canal long and straight. Sculptured with a distinct keel on the lower half of the whorls, 9 to 10 smooth secondary spiral threads above and below the keel, a narrow presutural cord, lowest sharp ridge begins at the end of the siphonal notch. Colour white with dark brown spots on the keel and dark brown axial streaks.

India : Andhra Pradesh: Visakhapatnam; Tamil Nadu: Madras; Pondicherry, common. Indo-Pacific, Indian Ocean to the Fiji Islands.

Synonym : *Pleurotoma marmorata* Lamarck, 1822

Lucerapex indagatoris (Finlay, 1927)

(Pl. 86, fig. 8, 9)

Shell small, 34 mm in height and 12 mm in width, elongate fusiform, spire elongate but less than half the height of the shell. Siphonal canal broad, sinus broadly open and U-shaped. Sculptured with peripheral row of gemmules, subsutural keel of weak gemmules on the spire whorls and spiral striae on the body whorl becoming obsolete towards the anterior end. Colour white.

India : Investigator Sta. 232-Laccadive Sea. 435 fms. off Travancore, 360 fms (E. A Smith-Powell, 1964).

Synonym : *Pleurotoma optata* E. A. Smith, 1894

Xenuroturris cingulifera cingulifera (Lamarck, 1822)

(Pl. 86, fig. 1, 2)

Shell of medium size, up to 50 mm in height, solid, spire high, more than half the total height, aperture small, columella smooth, posterior sinus deep, siphonal canal broad and short, slightly recurved. Sculptured with double-corded keel just below the suture followed by close-set spiral threads below. Colour cream, ornamented with axially elongate dark brown spots on the cords of the keel and minute reddish brown dots on the spiral cords, aperture and columella white.

India : Andamans, not common. Indo-Pacific, Red Sea to Fiji, not common.

Gemmula congener congener (E. A. Smith, 1894)

(Pl. 85, fig. 2)

Shell of medium size, up to 45 mm in height, solid, spire high, half the total height, columella with smooth callus deposit, posteriorly with deep sinus, outer lip thin, with a deep U-shaped notch, siphonal canal broad and short. Sculptured with strong spiral cords bearing gemmules, body whorl with a strong peripheral carina ornamented with gemmules and five to six fine spiral cords with close-set gemmules. Colour cream, without any ornamentation, aperture white, columellar callus shining white.

India : Bay of Bengal, 234 m. East Africa to Philippines.

Gemmula monilifera (Pease, 1860)

(Pl. 85, fig. 7)

Shell small, up to 30 mm in height, solid and narrow, spire half the total height, aperture narrow, columella with thin callus, almost straight, smooth, outer lip with a broad U-shaped notch, posterior sinus absent, siphonal canal narrow and moderate, almost straight. Sculptured with narrow peripheral carina bearing gemmules, one raised spiral cord with a thin spiral cord below on spire whorls, body whorl with one granulated peripheral carina and three raised spiral cords below followed by indistinct spiral cords below up to the posterior edge of the aperture. Colour wheatish brown, aperture and columella white.

India : Karnataka: Mangalore, 45 to 55 m.

***Gemmula oldhami* (E. A. Smith, 1894)**

(Pl. 85, fig. 1)

Shell of medium size, up to 45 mm in height, solid, spire slightly less than half the total height, aperture narrow. Columella with slightly broad callus, with plicae in the centre, posterior sinus very small, broad and shallow. Sculptured with peripheral carina bearing gemmules as in *G. speciosa speciosa*, body whorl with several, close-set spiral cords bearing gemmules. Colour cream, aperture and columella dull white.

India : Laccadive Sea, 660 m. Indian Ocean.

***Gemmula speciosa* (Reeve, 1843)**

(Pl. 85, fig. 10)

Shell of medium size, up to 50 mm in height, solid, spire half the total height, sutures channeled, shell narrower than in the preceding species, columella, with callus, smooth, posterior sinus narrow and small, outer lip with narrow notch, siphonal canal slightly drawn out. Sculptured with peripheral carina bearing gemmules and one or two fine spiral cords, body whorl with a distinct gemmulated peripheral carina and five to six widely spaced spiral cords. Colour dull brown, aperture and columella white.

India : Bay of Bengal. Elsewhere : Arabian Sea, Gulf of Martaban (110 m), China Sea, Philippines.

Synonym : *Pleurotoma carinata* (Gray, 1834)

***Gemmula vagata* (E. A. Smith, 1895)**

(Pl. 85, fig. 3–6)

Shell moderately large, up to 55 mm in height, spire high but less than half the total height, aperture a little broad. Columella without callus, smooth, outer lip with a broad and deep notch, siphonal canal narrow and elongate. Sculptured with strong peripheral carina bearing gemmules and several spiral cords below.

India : Lakshadweep, Andamans. Indian Ocean.

***Turridrupa bijubata* (Reeve, 1843)**

(Pl. 86, fig. 12, 13)

Shell small, up to 8 mm in height and 3 mm in width, spire high, almost twice the height of aperture, anterior canal short and broad. Sculptured with three strong, raised spiral keels on the

spire whorls, body whorl with 6–7 keels on the top and 5–6 weak spiral striae on the base, interstices between the keels with fine spiral threads. Colour light chocolate and keels light brown.

India : West Bengal : Digha, intertidal sand; Andamans. Indo-Pacific.

Unedogemmula unedo (Kiener, 1840)

(Pl. 85, fig. 8, 9)

Shell large, up to 75 mm height, solid, fusiform, spire elongate, less than half the total height, upper part of whorls convexly sloping, lower part rounded, aperture broad, outer lip thin with deeply 'U' shaped notch, siphonal canal long and slightly curved. Sculptured with strong carina on the upper half of each whorl and strong, sharp edged spiral ridges. Colour pale yellow flecked with brown, aperture and columella white.

India : Gujarat (80 m), Andamans (340 m). Elsewhere: Gulf of Oman.

Subfamily DRILLINAE

Austroclavus exasperatus (Reeve, 1843)

(Pl. 86, fig. 3, 4)

Shell small, up to 30 mm in height, solid, spire half the total height, aperture short and narrow, columella with callus, a strong parietal tubercle, outer lip thick with a notch below the tubercle, siphonal canal a broad shallow depression. Sculptured with raised axial nodules and fine axial growth striae. Colour cream, ornamented with dark brown, close-set, elongate axial lines just below the nodules on the body whorl, aperture and columella white.

India : Andamans.

Tomopleura vertebrata (Smith, 1875)

(Pl. fig.)

Shell small, up to 20 mm in height, suture incised, aperture small, outer lip corrugated, posterior sinus moderately deep, anterior canal broad and truncated. Sculptured with strong spiral ridges with distinct axial threads in the interspaces. Colour yellowish white, aperture and columella white.

India : Maharashtra, Tami Nadu : Madras; Orissa, West Bengal. Elsewhere : Indo-Pacific.

Subfamily CRASSISPIRINAE

Funa flavidula (Lamarck, 1822)

(Pl. 86, fig. 5)

Shell of medium size, up to 35 mm in height, thick, elongate fusiform, spire almost half the total height, sutures distinct, aperture flaring with thickened outer lip, columella straight, with callus on the upper part, posterior sinus not very deep, siphonal canal broad and short. Sculptured with strong, rather close-set axial ribs crossed by spiral threads, a row of subsutural beads and distinct spiral threads on the base of the body whorl. Colour yellowish with dark brown bands, aperture light orange.

India : Tamil Nadu. Elsewhere: Gulf of Arabia.

Funa tayloriana (Reeve, 1846)

(Pl. 86, fig. 14, 15)

Shell small, up to 30 mm in height, solid, elongate fusiform, spire half the total height, sutures shallow, aperture rather narrow, columella with callus, outer lip strongly convex, posterior sinus deep and opening slightly upwards, siphonal canal broadly open and truncated. Sculptured with strong, widely-spaced axial ribs crossed by weak spiral threads, axial ribs on the body become obsolete towards the base and spiral ridges become prominent. Colour cream with indistinct brownish dots.

India : Andhra Pradesh: Visakhapatnam; Andamans. Elsewhere: Gulf of Arabia.

Subfamily ZONULISPIRINE

Ptychobela griffithii (Gray, 1834)

(Pl. 86, fig. 11)

Shell small, up to 22 mm in height, solid, fusiform, spire about half the total height, sutures adpressed, aperture rather wide, slightly concave, without much callus, outer lip slightly thickened, posterior sinus deep, siphonal canal moderately long. Sculptured with axial nodes on the shoulder of each whorl and smooth spiral threads but no subsutural cord. Colour light brown.

India : Bay of Bengal. Indian Ocean.

***Ptychobela nodulosa* (Gmelin, 1791)**

(Pl. 86, fig. 6)

Shell of medium size, up to 35 mm in height, spindle shaped, spire slightly more than half the total height, whorls with rounded periphery. Aperture a little broad, columella with callus posteriorly, outer lip thick, with posterior sinus, notch on the outer lip deep and rounded, siphonal canal short. Sculptured with strong, broadly rounded spiral ribs and 2-6 regular spiral striae in the interspaces, a low, keeled spiral rib generally made up of two close-set ridges just below the suture, portion below this a little deeply hollowed. Colour dull brown with yellowish peripheral band, a dark reddish-brown zone at the shoulder, a lighter brown zone at the base of the body whorl.

India : Maharashtra : Bombay; Tamil Nadu : Madras, Porto Novo, Gulf of Mannar (Krusadai Island); Pondicherry, Andhra Pradesh : Visakhapatnam, Orissa. Indian Ocean.

Synonym : *Brachytoma crenularis* Lamarck : Gravelly, 1942; Satyamurti, 1952.

Subfamily RAPHITOMINAE

Some prefer to use the name Daphnellinae since the important diagnostic characters of the genus *Raphitoma* are in doubt.

***Daphnella lymnaeformis* (Kiener, 1840)**

(Pl. 86, fig. 7)

Shell small, up to 15 mm in height, thin, spire almost as high as the aperture, whorls regularly convex, sutures slightly adpressed. Aperture narrow and finely striate within, columella concave and smooth, outer lip thin and convex, with narrow and deep notch, siphonal canal spout shaped. Sculptured with short lamella at the sutures and numerous fine spiral striae crossed by longitudinal striae giving the shell a minutely cancellate appearance. Creamy white, ornamented with zigzag brown markings.

India : Andhra Pradesh: Visakhapatnam, not common. Indian Ocean to Fiji Islands.

A Checklist of Turridae from India

A list of species reported from India is given below. These species are not included in the text as either the specimens are not available for study or their identity not established. The list however, is not exhaustive. The localities are given wherever known.

Subfamily TURRINAE

1. *Turris annulata* (Reeve, 1843) Bombay
2. *Turris crispa crispa* (Lamarck, 1816)
3. *Turris crispa variegata* (Kiener, 1839) West Coast of India
4. *Turris garnonsii* (Reeve, 1843)
5. *Turris spectabilis* (Reeve, 1843)
6. *Turris undosa* (Lamarck, 1816) South India.
7. *Gemmula congener mekranica* (Vredenburg)
8. *Gemmula hombroni* (Hedley, 1922)
9. *Gemmula gilchristi* (Sowerby, 1902) Andaman Islands
10. *Gemmula sindiensis* (Vredenburg)
11. *Lophiotoma abbreviata abbreviata* (Reeve, 1843)
12. *Lophiotoma abbreviata ustulata* (Reeve, 1846)
13. *Lophiotoma albina* (Lamarck, 1822)
14. *Epidirone multiseriata* (Lamarck, 1822)
15. *Turridrupa acutigenmata* (E. A. Smith, 1877) East Coast of India
16. *Turridrupa cerithina* (Anton)
17. *Turridrupa decepatrix* Hedly, 1922
18. *Turridrupa prestoni* Powell, 1967
19. *Unedogemmula deshayesi* (Doumet, 1839)

Subfamily CLAVINAE

20. *Clavus echinata* Lamarck
21. *Clavus enna* Dall
22. *Clavus wilmeri* E. A. Smith
23. *Splendrilla persicus*

Subfamily TURRICULINAE

24. *Turricula ceylonica* (E. A. Smith)
25. *Turricula nellei spuris* (Hedley)
26. *Comitas breviplicata* (E. A. Smith, 1899)
27. *Comitas margaritae* (E. A. Smith, 1904) Andamans, 750 m.
28. *Comitas eurina* (E. A. Smith, 1895) off South India
29. *Comitas exstructa* (von Martens, 1903)

- 30. *Comitas symbiotes* (Woodmason and Alcock, 1891)
- 31. *Marshallena philippinarum* (Watson, 1882)
- 32. *Paradrillia inconstans prunulum* (Melvill and Standen, 1901)
- 33. *Paradrillia melvilli* Powell, 1969
- 34. *Typhlosyrinx praecipua* (E. A. Smith, 1899)

Subfamily ZONULISPIRINAE

- 35. *Ptychobela incerta* (E. A. Smith)
- 36. *Ptychobela major* (Reeve)

Subfamily CLATHURELLINAE

- 37. *Eucithara coronata* (Hinds, 1843)
- 38. *Eucithara duplaris* (Melvill, 1923) Andaman Islands
- 39. *Eucithara novaehollandiae* (Reeve) (Syn. *E. crassilabrum* Reeve)
- 40. *Eucithara vittata* (Hinds)
- 41. *Gingicithara cylindrica* (Reeve)
- 42. *Gingicithara lyrica* (Reeve, 1846)
- 43. *Citharamangelia townsendi* (Sowerby)
- 44. *Etrema gravelyi* (Winckworth, 1940) Orissa, Tamil Nadu
- 45. *Etrema spurca* (Hinds)
- 46. *Lienardia malleti* Recluz
- 47. *Lienardia cosmia* (Winckworth, 1940) Orissa, Tamil Nadu

Subfamily MANGELIINAE

- 48. *Heterocithara masoni* (Nevill)
- 49. *Pseudoraphitoma fairbanki* (G. & H. Nevill) Bombay, Orissa and Andamans.

Subfamily RAPHITOMINAE

- 50. *Pseudodaphnella fusoides* (Reeve)
- 51. *Pseudodaphnella lemniscata* (Nevill)
- 52. *Pseudodaphnella lucida* (Smith)
- 53. *Pseudodaphnella maculosa* (Pease)
- 54. *Pseudodaphnella nexa* (Reeve)

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Family TEREBRIDAE

Pencil or Auger Shells

Shell is small to large in size, long and narrow with many whorls and a high pointed spire. Body whorl is more or less small with a small aperture. Outer lip is simple. Columella is thickened and smooth except for a prominent fold anteriorly. Posterior sinus usually is distinct and the anterior canal is truncate. Shell resembles that of a screw shell (*Turritella*) but can easily be differentiated by the shape of its aperture, fold on the columella and in possessing an anterior canal. Operculum is corneous, ovate, claw-like and pointed posteriorly with a terminal nucleus.

Head bears a pair of tentacles with eyes situated at the tips of short eyestalks. Eyes may sometimes be absent. Foot is small, rounded anteriorly and pointed posteriorly. Proboscis is thin, invertible or polyembolic with a proximal buccal cavity, which consists of an outer eversible labial tube and an inner retractile buccal tube. Radula may be absent or reduced with the formula of 1-0-1. A poison gland is present. Salivary glands may be present but the Leiblein gland is absent. Sexes are separate. Male has a very long penis.

Augers are carnivores feeding on polychaetes and hemichordates. Majority are shallow water inhabitants of sandy shores and live buried in the sand. The family consists of eight genera and about 200 species. Four genera and about 25 species are reported from India. These genera are differentiated on the basis of radular characters. There is no radular ribbon in *Terebra*. In *Duplicaria* and *Hastula* the radula has a pair of slender and curved teeth in each row. In *Impages* there is a cluster of teeth similar in shape and size as in the Conidae.

Terebra areolata (Link, 1807)

(Pl. 88, fig. 1)

Shell large, up to 120 mm in height, whorls 20 to 21, stout. Aperture broadly oval, columella rather straight with a strong fasciole and a ridge. Surface smooth except for growth striae, a spiral groove divides the whorl into a smaller (one third) upper part and a broad (two-thirds) lower part. Colour shining cream, ornamented with three rows of blackish brown squarish blotches on spire whorls and four rows on the body whorl, the squares in the lower most row larger than others.

India : Lakshadweep, Andamans. Indo-Pacific.

Synonym : *Terebra muscaria* Lamarck, 1822.

Terebra chlorata Lamarck, 1822

(Pl. 88, fig. 2)

Shell moderately large, up to 65 mm in height, solid with about 14 whorls. Aperture small, outer lip thin, lower part of columella not in line with the outer lip. Surface smooth, obsolete

plications on the early whorls, a deep groove below the sutures. Colour white, ornamented with irregular, purple- brown blotches and wavy lines.

India : Nicobars. Tropical Indo-Pacific.

***Terebra commaculata* (Gmelin, 1791)**

(Pl. 87, fig. 5, 6 and Pl. 88, fig. 9)

Shell large, up to 95 mm in height, with about 25 flattened whorls. Aperture small and almost rectangular with twisted columella. Shell scabrously latticed, with two spiral bands of nodules divided by a groove below the suture, often the nodules fused together to form a single raised band, fine spiral ridges crossed by axial riblets. Colour white ornamented by rather rectangular brown blotches bordered by a white ridge with thin brown dashes, about six per whorl, blotches extend lengthwise.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu : Madras; Pondicherry, Andamans, rare. Southeast Asia.

Synonym : *Terebra myuros* Reeve, 1860

***Terebra crenulata* (Linnaeus, 1758)**

(Pl. 88, fig. 3)

Shell large, up to 115 mm in height, solid, with broad body whorl gradually tapering into the apex, with about 18 rounded whorls. Aperture of moderate size, with rather smooth columella, short but strong fasciole. Sculptured with small nodules just below the suture on each whorl, a small constriction below the nodules; early whorls with axial plicae, only growth lines on the latter whorls. Colour yellowish-brown, with white nodules, three or four spiral rows of reddish brown dots on the body whorl, two on other whorls, small fine streaks of reddish-brown between the nodules.

India : Lakshadweep, Andamans. Tropical Indo-Pacific.

***Terebra dimidiata* (Linnaeus, 1758)**

(Pl. 88, fig. 4)

Shell very large, up to 140 mm in height, solid with about 20 rounded whorls. Aperture broadly oval, outer lip a little flared at the base, columella rather straight, with a weak plait, fasciole strong. Surface smooth and shining, early whorls with axial plications and later ones with growth lines, a slight constriction below the suture dividing each whorl into a narrow upper one third and a broad lower two-third. Colour orange-red with wavy white streaks often bifurcating at the top.

India : Lakshadweep, Andaman and Nicobar Islands, common. Tropical Indo-Pacific.

***Terebra guttata* (Roeding, 1798)**

(Pl. 88, fig. 6)

Shell large, up to 115 mm in height, about 21 whorls. Aperture small and rectangular, outer lip and columella straight, fasciole rather weak, anterior canal broad and recurved to the left. Sculptured with obsolete growth lines, area below the suture slightly raised. Colour orange brown, ornamented with one row of large white spots just below the suture on the raised surface of spire whorls, and two rows on the body whorl.

India : Andamans, rare. Indo-Pacific.

Synonym : *Terebra oculata* Dillwyn, 1817

***Terebra maculata* (Linnaeus, 1758)**

(Pl. 88, fig. 5)

Shell largest in the genus, up to 140 mm in height, stout and heavy with about 18 rounded whorls, broader than in other species. Aperture rather wide, columella smooth except for a weak parietal fold, fasciole small but strong with a central groove. Surface usually smooth except for weak axial plications on the early whorls and growth lines on the latter whorls. Colour very distinct, white, ornamented with two spiral rows of irregular, purple brown blotches on each whorl and on the upper part of the body whorl, the latter with about five pale tan rectangular blotches on the body whorl.

India : Lakshadweep, Andamans, common. Tropical Indo-Pacific.

***Terebra nebulosa* Swainson, 1825**

(Pl. 88, fig. 8)

Shell large, up to 75 mm in height, about 20 whorls. Aperture small and rectangular, with almost a straight outer lip constricted at the upper end, columella in line with the lip at the base. Sculptured with 18 to 25 broad, close-set and curved axial ribs with spiral grooves in interstices and punctate spiral groove at the suture. Colour white, ornamented with large, irregular, orange-red blotches, and band of same colour at the base of the body whorl.

India : Andamans. Tropical Indo-Pacific.

Shell bears some resemblance to that of *T. undulata* but can be differentiated by the colour pattern.

***Terebra subulata* (Linnaeus, 1767)**

(Pl. 88, fig. 7)

Shell large, up to 115 mm in height, slender with about 25 whorls and an acute apex. Aperture very small, with thin outer lip and twisted columella, small fasciole, truncated and curved anterior

canal. Sculptured with fine axial threads and irregular, weak spiral grooves, the area below the suture raised into a spiral band. Colour very distinct, cream, ornamented with two rows of dark brown squarish blotches on the early whorls and three rows on the body whorl.

India : Lakshadweep, Tamil Nadu : Madras, Gulf of Mannar (Krusadai Island); Andamans, moderately common. Indo-Pacific.

***Terebra columellaris* Gray, 1834**

(Pl. 89, fig. 2)

Shell of medium size, up to 45 mm in height, whorls 18 to 20. Aperture small, outer lip thin and constricted posteriorly, columella rather straight, anterior canal curved towards left. Sculptured with a row of white beads and punctate spiral groove at sutures, curved axial ribs with deep grooves in the interstices. Colour light orange-brown, interstices dark brown.

India : Andamans, not common. Andamans to Tropical Pacific.

***Hastula traillii* (Deshayes, 1859)**

(Pl. 89, fig. 3, 4)

Shell small, up to 25 mm in height, narrow and needle shaped, with slopingly flattened whorls, sutures indistinct. Aperture small, columella arched and short. Shell surface almost smooth, except for elongate plications on the upper part of the whorls. Colour shining white, apex lead colour, whorls with ash coloured spiral bands and indistinct spots below suture.

India : Orissa : Gopalpur, Paradip; Andhra Pradesh: Bheemunipatnam, Visakhapatnam; Tamil Nadu : Madras, Nagapattinam. Indian Ocean.

***Hastula inconstans* (Hinds, 1844)**

(Pl. 89, fig. 1)

Shell small, up to 20 mm in height, thin, narrow and acicular with about 12 whorls. Aperture short, broadly effused at base, columella calloused, very short and straight, keeled at base. Sculptured with elongately plicated axial ribs on the upper part of the whorls. Colour shining fawn-white or ashy, with pale band towards base, sutures white with pale band and brown dots below.

India : Tamil Nadu : Tranquebar; Andamans.

Synonym : *Terebra aciculina* Reeve, 1860.

***Hastula lauta* (Pease, 1869)**

(Pl. 89, fig. 8, 9)

Shell small, up to 20 mm in height with about 12 whorls. Aperture small. Sculptured with straight axial ribs and a deep spiral groove at sutures. Colour dark gray, ornamented with blackish brown squarish spots at sutures and intermediate white spots, nuclear whorls tan coloured.

India : Andamans. Andamans to Pacific.

***Duplicaria duplicata* (Linnaeus, 1758)**

(Pl. 87, fig. 2, 3 and Pl. 89, fig. 6, 7)

Shell of medium size, up to 50 mm in height, narrowly elongate with 15 to 17 whorls, aperture small and ovate, columella twisted, anterior canal recurved. Sculptured with a deep sutural groove and 25 to 30 flat and close-set axial ribs, whorl divided by a spiral groove above the middle. Shell glossy, cream or brown coloured with darker rusty brown transpirally elongate markings and often with a pale band just above suture.

India : Tamil Nadu : Madras, Gulf of Mannar (Tuticorin, Pamban, Krusadai Island); Andamans, common. Indo-Pacific.

***Impages hectica* Linnaeus, 1758**

(Pl. 89, fig. 5)

Shell of medium size, up to 50 mm in height. Aperture broad at the base, columella smooth, fasciole with central groove. Surface smooth, callous near suture. Colour cream with slightly broken purple band below suture, columella brown.

India : Andhra Pradesh : Visakhapatnam; Tamil Nadu.

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Subclass HETEROBRANCHIA

The families Architectonicidae, Pyramidellidae, Amathinidae, and Mathildidae have confusing systematic history and do not constitute a well-defined group. Many have treated them under a superfamily Heterogastropoda. We have followed Vaught (1985) and grouped these families in a separate subclass. Shell is discoidal or conical to turriculate with usually an operculum. The protoconch is heterostrophic. The radula is modified taenioglossate or rachiglossate or absent. A ctenidium is present or absent. The subclass includes one superorder embracing four families, of which three are known from India.

Superorder ALLOGASTROPODA

Family ARCHITECTONICIDAE

Sundial Shells

Shell is minute to moderately large in size, from 3 to 70 mm in height. It is conical to discoid with an elevated or depressed spire. Whorls may be rounded or angular with a flat base. Aperture is rounded to angular. Umbilicus is very deep, may be narrow or wide. Surface usually is with strong sculpture consisting of spiral and radial ribs that are often beaded. Operculum is horny, thin, paucispiral to multispiral with a central or excentric nucleus and bears a characteristic internal spiral process.

Cephalic tentacles are broad and flattened. Mantle cavity contains a triangular ctenidium, an osphradium with a narrow ridge and a hypobranchial gland. Radula is taenioglossate-modified (0-2-1-2-0). Sexes are separate. Male has no penis. Larvae are pelagic with a long life.

These are tropical deepwater forms associated with coelenterates.

Architectonica laevigata (Lamarck, 1822)

(Pl. 90, fig. 4)

Shell small, up to 24 mm in height, depressedly conical with sharply angulated margin, whorls with four to five, roughly equal, flat ridges crossed by axial growth lines, with profuse blotches of pinkish purple, orange, brown or yellowish brown, bands always broken into blotches but not continuous as in *A. perspectiva*. Base fawn with blue tinge on broad middle area, and with brown radial markings on the periphery.

India : Gujarat : Gulf of Kachchh; Maharashtra : Bombay; Tamil Nadu (common), Pondicherry (not common), Orissa : Gopalpur, Puri, Konark, Paradip. Persian Gulf to Myanmar.

The species is distinguished from *A. perspectiva* in having four grooves followed by deep suture, umbilicus bordered by beaded margin with two grooves, and brown blotches below suture.

Architectonica perspectiva (Linnaeus, 1758)

(Pl. 90, fig. 1–3 and Pl. 91, fig. 1–2)

Shell small, up to 20 mm in height, depressedly conical, moderately thick, flattened base and angulated periphery. Aperture ventral, subquadrangular, outer lip sharply angulated at lower margin, umbilicus wide with strongly plicated, brown tinted margin. Whorls transpirally obliquely striated throughout, distinct narrow spiral groove below suture. Upper edge of each whorl with three prominent, unbroken spiral bands of brown, white and chocolate in that order. Along lower edge a spiral rib, alternately coloured with interrupted bands of white and brown or dark brown, on body whorl this rib followed by distinct white slender thread-groove; base slightly bulged and radiately striated, periphery with broad raised margin divided medially by closely-set spiral double groove, umbilicus lined with denticulate ridge. Base fawn, with brown dots on outer ridge and inner edge of plicate area, beads white and denticles stained brown.

India : West Bengal : Digha; Andhra Pradesh : Visakhapatnam; Tamil Nadu : Porto Novo, Point Calimere, Pamban *etc.*, common. Indo-Pacific.

Heliacus (Heliacus) areola (Gmelin, 1791)

(Pl. 91, fig. 6–8)

Shell minute, up to 6 mm in height, thick, broader than high, spire dome-shaped, whorls rounded with a convex base and round aperture. Sculptured with four coarse spiral ribs separated by narrow grooves on the spire, sutural rib more distinct, ribs radially grooved, body whorl with four spiral ridges above periphery and three on the base, two cords within the narrow umbilicus. Colour cream, ornamented with radial blackish brown streaks, cream around umbilicus and columella, outer lip margin stained with blackish brown streaks.

India : Goa. Indian Ocean.

Heliacus dorsuosus (Hinds, 1844)

(Pl. 91, fig. 3–5)

Shell minute, up to 6 mm in height, disc-like and convexly lenticular resembling button shell, whorls rounded leading to an almost circular mouth, broadly umbilicate with a crenulated umbilical margin. Sculptured with finely beaded spiral ribs, lowest rib of each whorl most prominent, periphery of body whorl with two prominent ridges with channel in between.

Continuous brown bands next to suture and below upper sulcus, and interrupted brown bands around periphery and near umbilicus.

India : Tamil Nadu: Madras, Gulf of Mannar (Tuticorin, Pamban); Andamans. Indo-Pacific.

***Heliacus stramineus* (Gmelin, 1791)**

(Pl. 91, fig. 3-5)

Shell small, up to 12 mm in height, discoid, thick, almost twice as wide as high, flat topped with a concave base, whorls almost rounded leading to a circular aperture, broadly umbilicate, corrugated all around, two cords within umbilicus. Sculptured with fine beaded spiral ridges and spiral grooves between deep narrow suture and periphery, three ridges between periphery and base separated by broad striated spaces, small cord between lower two ridges, spirally ridged base rather narrow, oblique growth lines on the surface. Colour uniformly light brown throughout without any markings.

India : Tamil Nadu: Gulf of Mannar (Tuticorin), Point Calimere; Pondicherry, very rare. Indo-Pacific, shallow water.

***Philippia radiata* Roeding, 1798**

(Pl. 91, fig. 9, 10)

Shell relatively smaller than in *Architectonica*, height up to 22 mm, higher than broad, whorls rounded, mostly smooth with indistinct spiral striations and two prominent spiral cords near suture, base convex with groove at periphery, umbilicus slightly open and deep, umbilical wall crenulate. Colour white, a broad reddish brown band below suture with oblique axial rays spreading down the whorls, umbilical area white surrounded by brown specks on rim.

India : South India. Indo-Pacific, common in certain localities.

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Family PYRAMIDELLIDAE

Shell is minute to small in size, up to 30 mm in height; pyramidal to turriculate with a tapering spire. Apex is tilted from the vertical axis. Apex of the shell is heterostrophic; the normal revolution of the whorls is dextral but the apical whorls are sinistral. Shape of the aperture is variable. Anterior siphonal canal is absent. Columellar margin may be smooth or may bear one to three plicae. Umbilicus is absent. Shell surface is smooth or may bear spiral or axial striae and nodules. Operculum is corneous, thin and paucispiral.

Tentacles on the head are short and shaped like donkey's ears. They have a ciliated antero-median groove and bear eyes on the inner margin. Foot is narrow. Mantle cavity bears ciliated strips. There is no ctenidium. Proboscis is very long and retractile. Radula is absent, but a hollow style is present. Oesophageal glands are absent but tubular glands are present.

Sexes are united and monaulic. Male part bears an invaginable penis. Eggs are deposited in gelatinous masses. A pelagic veliger stage is present in the development.

The snails have cosmopolitan distribution and occur from shallow intertidal region to greater depths. Majority of the species inhabit sandy bottom. These are predators or ectoparasites on other mollusks, sponges, coelenterates, sipunculans, crustaceans etc. They puncture the host's skin with the stylet and suck the fluids through the buccal pump.

The family is divided into four subfamilies, namely Pyramidellinae with two or three columellar plicae, Odostominae with a single columellar fold, Turbonillinae with smooth columella, and Cyclostremellinae with low spire. Hundreds of species were described. In India the first three subfamilies are represented by a few genera and species.

Subfamily PYRAMIDELLINAE

Pyramidella dolabrata terebellum (Mueller, 1774)

(Pl. 92, fig. 1, 2)

Shell small, up to 15 mm in height, thin, semitransparent, glossy, whorls eight, sutures lightly grooved. Columella expanded basally, with three folds, upper one more conspicuous and the two below small and close-set, outer lip thin, umbilicus deep, three dark brown lines seen through the aperture. Shell surface smooth with reddish brown spiral bands.

India : West Bengal: Digba; Andamans. Indo-Pacific, not common.

Pyramidella sulcata (A. Adams, 1855)

(Pl. 92, fig. 5)

Shell larger than in the preceding species, up to 25 mm in height, smooth and shining, whorls many, sutures grooved. Aperture lirate within, with three folds as in the preceding species,

umbilicus absent. Shell cream coloured, ornamented with chocolate-brown axial wavy lines or blotches, an indistinct white spiral band on the last and the penultimate whorl.

India : Lakshadweep, Andaman and Nicobar Islands. Indo-Pacific, moderately common.

***Otopleura auriscati* (Holten, 1802)**

(Pl. 92, fig. 6–8)

Shell small, up to 20 mm in height, solid, elongately ovate, whorls convex and slightly stepped at the sutures, outer lip thin. Columella flattened, with three folds, umbilicus absent. Creamy-white, ornamented with dark reddish-brown spots, sculptured with numerous angulate axial ribs and blunt nodules just below the sutures.

India : Andamans. Indo-West Pacific, moderately common.

Subfamily ODOSTOMINAE

***Odostomia babylonica* Winckworth, 1940**

(Pl. 92, fig. 9)

Shell minute, smaller than in *O. oxia*, up to 3 mm in height, pyramidal, with seven whorls, strongly turreted making a distinct series of steps broadly angled at the upper end, aperture ovately rounded, distinct spiral lirations within, columella with one tooth, outer lip smooth, with a minute umbilicus.

India : West Bengal, Orissa, Tamil Nadu.

***Odostomia oxia* Watson, 1886**

(Pl. fig.)

Shell minute, up to 5 mm in height, ovate with three to four whorls and deep sutures, columella with one fold, outer lip depressed below forming a notch, surface smooth.

India : West Bengal: Digha, occurs on *Donax incarnatus*. Elsewhere : Australia.

***Syrnola dubiosa* G. & H. Nevill, 1871**

(Pl. 71, fig. 8)

Shell small, up to 7 mm in length and 2 mm in width, elongate, less acuminate, whorls 10 with distinct sutures. Aperture subovate, contracted posteriorly and rounded at the anterior end, columella reflexed with a distinct plait. Shell usually smooth. Colour dull brown.

India : Puri (Type-locality), Orissa.

Subfamily TURBONILLINAE

Turbonilla felicitia Laseron, 1959

(Pl. 92, fig. 3)

Shell small, up to 8 mm in height, attenuately subulate, whorls 11 to 12, gradually increasing, constricted in the middle, aperture oval and distinctly angled above, columella slightly thickened. Sculptured with regular, strong, straight longitudinal ribs. Colour shining pale yellow.

India : West Bengal: Digha. Elsewhere : Australia.

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Family AMATHINIDAE

Shell is small, limpet-like or pyramidal. Protoconch whorls coil in a direction opposite to that of the spire. Aperture is large. Shell surface has either spiral striae or three carinae.

The family contains seven genera with only a few species.

Amathina tricarinata (Linnaeus, 1758)

(Pl. 93, fig. 1, 2)

Shell small, up to 20 mm in length, limpet-like, solid, dull, rather oval in shape, apex at the posterior end, three strong rounded ridges or carinae radiate from the apex and project beyond the outline of the shell, surface with wavy radiating ribs at the posterior end. Colour white and covered with brownish periostracum, inside white but with yellowish tint.

India : Goa, Lakshadweep: Minicoy Island; Andaman and Nicobar Islands. Indian Ocean.

REFERENCE

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Subclass OPISTHOBRANCHIA

Shell is absent in many, when present it may be external or internal. It is ovate to cylindrical in shape with a broad aperture and shortened whorls. In the family Juliidae the shell is exceptionally of two valves. Operculum is absent in the adults. The animal exhibits detorsion. The head possesses a cephalic shield. Mantle cavity is reduced. A bipectinate ctenidium is present in some. But in many it is replaced by secondary respiratory structures which can be seen in the form of dorsal cerata, anal tufts or anal leaflets etc. In a few, the respiration is integumentary. Nervous system is primitively streptoneurous, but secondarily euthyneurous in advanced forms. Sexes are united with internal fertilization in majority. These are predominantly marine.

The subclass is divided into nine orders and 165 families. Opisthobranchs are poorly represented in the National Zoological Collections. The difficulty in the collection and preservation of these molluscs and the difficulty in the identification of pickled specimens are some of the factors responsible for their poor state of knowledge in India. However, there are a few recent publications on the opisthobranchiate fauna of Gujarat coast (see Bibliography, Burn and also Narayanan). The reported occurrence of eight orders and as many as 50 families consisting of about 150 species is a poor representation in India as compared to 3400 species estimated to occur in the Indo-West Pacific Province.

Order CEPHALASPIDEA

Shell is mostly external, but often enclosed in the mantle. Operculum usually is absent. Foot has laterally expanded parapodial lobes. A flattened cephalic shield extends dorsally over the back. Eyes are sessile. Nervous system is euthyneurous. Sexes are united. These are benthic forms with carnivorous habits.

The order is classified into 15 families of which 10 are represented in India.

Family RINGICULIDAE

Shell is small, usually less than 10 mm in height, thick and rounded with an elevated spire. Aperture is large but looks reduced because of the protruding lamella from the outer lip and strong columellar folds. Outer lip is more or less thick bearing lamellations on the interior. Surface usually is smooth or may bear fine spiral sculpture. Operculum is absent.

The animal can be completely retracted into the shell. Foot is broad anteriorly. Cephalic shield is short, broad and bifid. Radula is small. Central tooth is absent and lateral teeth may be one or two in each row. There is a long proboscis. Sexes are united.

It is a monogeneric family represented by two species in India.

***Ringicula propinquans* Hinds, 1844**

(Pl. 92, fig. 12, 13)

Shell minute, up to 5 mm in height, thick, glossy, ovate, sutures deep, aperture narrow, columella thick, with two strong folds and a parietal ridge, outer lip thickened, with a prominent central tooth. Surface with widely spaced spiral grooves. Colour white.

India : Orissa: Puri; Andhra Pradesh: Vasishtha Godavary Estuary near Narsapur.

***Ringicula encarpofrens* de Folin, 1867**

(Pl. 92, fig. 10, 11)

Shell minute, up to 4 mm in height, thick with low spire, outer lip expanded and serrated. Surface with regular, distinct spiral striae.

India : West Bengal, Orissa, Tamil Nadu, not common. Indo-West Pacific.

The species differs from *R. propinquans* in having a more globose shell, serrated outer lip and distinct spiral striations on the surface.

Family HYDATINIDAE

Shell is of small to medium size, thin and external. It is elongate-globose to rounded ovate. Spire is short and rather depressed. Body whorl is large and inflated with a large aperture, which is narrow above and broadly rounded below. Surface usually is smooth or with weak striations and bear conspicuous colour bands. Operculum is absent. The animal is brightly coloured and can be completely withdrawn into the shell.

Foot is large and strong, bearing large parapodia that can cover the whole shell. Cephalic shield has two pairs of anterior lobes and a pair of strong posterior lobes. A feather-like rhinophore is present between the anterior lobes. Eyes are sessile and situated between the posterior lobes. Proboscis is long and strong. Radula is with or without central tooth but with numerous lateral teeth. Sexes are united. Penis is strong and retractile.

These are vermivorous, feeding exclusively on cirratulid polychaetes. The family includes two genera, namely *Hydatina* and *Micromelo*.

Hydatina zonata (Lightfoot, 1786)

(Pl. 93, fig. 3, 4)

Shell small, up to 30 mm in height, thin and glossy, body whorl ovoid and inflated, with a flat or sunken spire, suture a deep groove, aperture wide with a thin outer lip and smooth columella. Surface smooth except for thin growth lines. Colour creamy white, ornamented with two very broad spiral bands of oblique, close-set axial lines of brown colour, edges on either side of these bands with unbroken dark brown line.

India : Gujarat. Indian Ocean.

REFERENCE

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Family SCAPHANDRIDAE

Shell is minute to medium in size, up to 50 mm in height, conical to subcylindrical, with a more or less dilated body whorl and a flattened or sunken spire. Aperture is more or less broad anteriorly and narrow posteriorly. Columella is with or without folds. Surface of the shell is smooth or with spiral striations and often with rows of punctations. Operculum is absent.

Foot is as long as the shell. Cephalic shield bears no tentacles but has short posterior lobes. Eyes generally are absent. Radula has a small central tooth, a large lateral tooth and several marginal teeth.

Sexes are united. Penis is protrusible. Eggs are deposited in a mass attached to the substratum by a mucus cord. Development is indirect.

These occur in soft, muddy or sandy substrata from intertidal zone to greater depths (up to 2000 m). They feed on small foraminiferans and molluscs. The family includes four genera, *Scaphander*, *Tornatina*, *Cylichna* and *Acteocina*.

Acteocina estriata (Preston, 1914)

(Pl. 93, fig. 6)

Shell minute, up to 4 mm in height and 1–5 mm in width, cylindrically ovate, spire moderately exserted, suture narrowly channelled. Aperture narrow at the posterior end and broad at the anterior end, columella not much curved, outer lip obtusely angled posteriorly and slightly dilated anteriorly.

India : Orissa : Chilka Lake. Manikpatna (about 1 m depth), off Balugaon (1–2 m depth).

Preston (1914) described another species *Tornatina soror* from Manikpatna, which looks similar to *A. estriata*.

Scaphander andamanicus E. A. Smith, 1894

(Pl. 93, fig. 5)

Shell small, up to 25 mm in height and 20 mm in width, thick, solid and bulla-like appearance. Aperture wide, columella curved at the anterior end, smooth and with callus, outer lip thick and posteriorly extends beyond the level of the shell. Surface smooth except for growth striae. Colour dull yellow.

India : Marine Survey Sta. 273-Andamans, 870-1170 fms; off Malabar Coast.

Family PHILINIDAE

Shell is thin, plate-like and enclosed within the mantle. Body whorl is dilated and the apex is involute and sunken. It usually is whitish and without any strong sculpture. Aperture is wide and ear-shaped. Operculum is absent.

Animal is white or light flesh coloured. It has thick and broad foot bearing elongate parapodia. The large cephalic shield occupying two-thirds of the body length is divided into two lobes posteriorly. Eyes may be absent but there is a pair of rhinophores. Radula has no central tooth and marginals may be absent or six in number. It has the formula [(0-6)-1-0-1-(0-6)]. There is a strong gizzard bearing three strong and thick plates. Sexes are united. A protrusible penis is present. Eggs are laid in gelatinous mass. A pelagic veliger larval stage is present in the development.

It is a monogeneric family having cosmopolitan distribution and numerous species, which occur at 10 to 20 m depth in the sublittoral region. These usually are collected in the fishing nets. The snails feed on foraminiferans, small snails and bivalves.

Philine aperta (Linnaeus, 1758)

(Pl. 93, fig. 7)

Shell small, up to 20 mm in height, fragile, milky white, oval with a large body whorl and broad aperture, spire almost obsolete. Shell surface with coarse growth lines. Shell completely enclosed by the mantle. Animal white with a blunt tail.

India : Andhra Pradesh: Visakhapatnam, common, 20 to 50 m. Indo-Pacific.

Family BULLIDAE

Bubble Shells

Shell is rather strong and roundly ovate. Spire is sunken. Aperture is as long as the shell. It is broadly ovate anteriorly but narrow posteriorly. Columella is concave, with thin callus and without any folds. Outer lip is slightly thickened. Colouration consists of reddish brown flecks. Animal is completely retractable into the shell. Operculum is absent.

Cephalic shield is somewhat indented medially in front and has two large, strong lobes posteriorly. There is a pair of lateral rhinophores. Eyes are transparent. Foot is short and broadened anteriorly but rounded posteriorly. Radula has the formula of 1-2-1-2-1. Sexes are united. Eggs are laid in long ribbons. Free-swimming veligers are released. Bubble shells are sand dwellers and are carnivorous.

***Bulla ampulla* Linnaeus, 1758**

(Pl. 93, fig. 9)

Shell of medium size, up to 45 mm in height, moderately solid, broadly ovoid, spire very much invaginated and marked by a depression, body whorl expanded, outer lip extends posteriorly, columella smooth and with thin callus. Shell surface smooth and polished, cream coloured with pale brownish red or clouds of light brown, rarely with two broad spiral bands, aperture and columella white.

India : East and West Coasts, common. Indo-Pacific.

Family HAMINEIDAE (Atyidae)

Shell usually is external and similar to that in Bullidae, but thinner and fragile with an involute spire covered by the expansion of the body whorl. Aperture is large extending along the length of the shell and the posterior part of the outer lip is detached from the apex. Surface of the shell is without pronounced sculpture. It is generally white in colour and covered by a brownish periostracum. Animal may be completely retractable into the shell, but often it may be larger than the shell. There is no operculum.

Foot is large with well-developed parapodia. Cephalic shield consists of two short rounded posterior lobes covering the anterior part of the shell or may be truncate. Gizzard has strong plates to assist in grinding of the organisms taken in. Sexes are united with a protrusible penis.

Some are shallow water inhabitants of the intertidal sandy habitats and a few may extended to depths at 3000 m. Indian species are less known. All the four subfamilies namely, Atyinae in which animal is completely retractable into shell; Bullactinae, in which shell is not retractable; Lathophthalminae and Hamineinae occur in Indian seas. But collections include a few species of Atyinae and Hamineinae from India.

Subfamily ATYINAE

Atys cylindricus (Helbling, 1779)

(Pl. 93, fig. 8)

Shell small, up to 15 mm in height, thin, fragile, narrowly subcylindrical, spire sunken, aperture narrow and extends the whole length of the shell, expanded at the base, outer lip extends beyond the apex of the shell, columella smooth, rarely with a weak fold at the base. Sculptured with weak growth striae and a few incised spiral lines on the top and at the base enclosing in between a smooth central area. Colour white.

India : Andamans.

Atys elongatus A. Adams, 1850

(Pl. 93, fig. 11, 12)

Shell small, up to 25 mm in height, narrow and elongate, spire deeply sunk. Aperture narrow and widening gradually towards the anterior end. Body whorl encircled by grooves on the anterior and posterior one thirds leaving in between smooth or obsoletely sculptured area, mid-dorsal with an elevation. Colour yellowish white.

India : Andamans, rare.

It differs from *Atys hyalina* in being narrower and in the absence of sculpture on the median one-third.

Atys hyalina Watson

(Pl. 93, fig. 10)

Shell small, up to 20 mm in height, thin, spire sunken. Aperture protruding beyond the level of the shell, narrow at the posterior but wider at the anterior end. Body whorl encircled by distinct grooves separated by wide spaces and visible through the aperture, keel-like structure on the mid-dorsal area bear indistinct axial ridges. Colour pale yellow with dark coloured spiral grooves.

India : Andamans, rare.

Atys naucum (Linnaeus, 1758)

(Pl. 93, fig. 13)

Shell larger than in *A. cylindricus*, up to 35 mm in height, globose, spire sunken, aperture large and expanded anteriorly, outer lip looks more detached than in *A. cylindricus*, columella with an angulate curved fold anteriorly. Sculptured with distinct spiral lines on the top and at the bottom leaving a smooth centre. Colour white and covered by brown periostracum, often decorated with reddish brown wavy axial streaks.

India : Andamans.

Synonym : *Atys ferruginosa* A. Adams, 1850

Subfamily HAMINEINAE

Haminea crocata Pease, 1860

(Pl. 94, fig. 2, 3)

Shell small, up to 15 mm in height, thin and fragile, oval in shape with broad posterior end, semitransparent, light bluish in living condition but becomes pale yellow on preservation. In live condition mantle covers most part of the shell.

India : West Bengal: Sagar Island; Orissa: Chilka Lake; Tamil Nadu: Madras. South Africa to Australia.

Haminea elegans A. Adams

(Pl. 94, fig. 1)

Shell small, up to 20 mm in height, oblong-ovate, narrow at the posterior and a little expanded at the anterior end. Aperture narrow at the posterior, elevated and acuminate, outer lip elongately produced and arched over above the middle. Colour white.

India : Andhra Pradesh : Masulipatnam, uncommon.

Family RETUSIDAE

Shell is minute in size, usually not more than 5 mm in height. It is cylindrical or pyriform in shape with an elevated or low spire. Aperture is narrow above and broad below. Columella is with one fold. Outer lip is thickened and smooth to serrate. Surface of the shell is either smooth or with spiral striations. Operculum is absent.

Anterior region has a small cephalic shield with two posteriorly directed tentacular processes bearing reduced and sessile eyes. Jaws and radula are absent. Sexes are united with monaulic condition. A protrusible penis is present. There is no larval stage as the development is direct.

The family consists of two genera, *Retusa* and *Volvulella* and about 100 species, which are distributed mainly in the Atlantic and Pacific Ocean. One species is known from India.

Retusa pyramidata (A. Adams, 1850)

(Pl. 94, fig. 4, 5)

Shell minute, up to 4 mm in height, pear shaped, fragile, spire sunken, outer end of outer lip slightly elevated, columella concave and calloused.

India : West Bengal, Orissa, Tamil Nadu.

Order SACOGLOSSA

Shell when present usually is univalved and rarely bivalved. Univalved shell has a large aperture. Animals are slug-like and small in size, usually less than 10 mm in length. Head bears paired rhinophores or lobes. Radula has a single blade-like uniseriate central tooth. The body may have dorsal papillae or cerata. Sexes are mainly united. These usually are associated with algae.

The order includes seven families, all of which are known to occur in India. These are small molluscs and need special efforts to collect. Only the following is described below.

Family JULIIDAE

Bivalve Gastropods

During the last century two important discoveries were made in the field of malacology – one the discovery of *Neopilina* in 1952 and the other, living bivalve gastropods in 1959. The latter was known among fossils. For a long time bivalve gastropods were placed in the class Bivalvia (Family Juliidae). The discovery of a new living species *Tamanovalva limax* Kawaguti and Baba, 1959 settled the taxonomic position of this group and is placed in Gastropoda.

These are microscopic gastropods with laterally compressed and slug-like body enclosed within two thin valves. The two fragile valves are united by a single subcentral round or horizontal adductor muscle. The characteristic feature of the shell is the presence of apically coiled protoconch on the left valve. The shell is not more than 10 mm in length.

Head bears a pair of small tentacles and grooved rhinophores. Eyes are situated on short projections from the middle of the neck. Foot is narrow, tapering posteriorly. The sole is medially grooved. Mantle cavity contains a laminate gill, small osphradium and a pigmented hypobranchial gland.

Buccal mass contains paired elongate buccal diverticula and salivary glands. Radula is uniseriate and blade-like. Sexes are united. Penis is on the right side of the head. Female gonopore opens medially on the right side of the foot.

Living bivalve gastropods were discovered first in Japan and since then there were records from several other localities (Kay, 1968; Ganapati and Sarma, 1972). The family is divided into two subfamilies, namely Juliinae which includes one genus *Julia* distributed in the Indo – Pacific and west coast of America, and Bertheliniinae which includes the genera *Berthelinia*, *Tamanovalva*, *Edentellina* and *Midorgia* distributed in the Indo-Pacific with a total of 18 species (3 species under Juliinae and 15 species under Bertheliniinae). The following five species were

reported from India *Tamanovalva limax*, Kawaguti and Baba, *Tamanovalva schlumbergeri*, Dautzenberg, 1895; *Julia burni*, Sarma, 1975; *Berthelinia (Tamanovalva) ganapatii*, Sarma, 1975; *Berthelinea (Tamanovalva) waltairensis*, Sarma, 1975. These are algal associates occurring mostly on *Caulerpa racemosa* (Sarma, 1975).

***Tamanovalva limax* Kawaguti and Baba, 1959**

(Fig. 38, 1–3)

Shell small, not more than 10 mm in length, elongately oval, valves equal, thin, fragile, transparent and light yellow in colour, protoconch of one and half whorls situated just behind the anterior one third of length. Adductor muscle scar round and in anterior half, firmly attached to the right valve. Rhinophores grooved, speckled with white dots, tentacles small and lobe-like, eyes situated on the prominence of neck, foot narrow with a medially grooved sole.

India : Andhra Pradesh (Visakhapatnam); Tamil Nadu (Gulf of Mannar). Occurs on *Caulerpa racemosa*. Elsewhere: Japan.

***Tamanovalva schlumbergeri* Dautzenberg, 1895**

(Fig. 38, 4–6)

Shell smaller than in *T. limax*, up to 0.46 mm in length and 0.31 mm in height, thin, transparent, fragile and equivalve, light greenish yellow, sculptured with fine concentric growth lines crossed by transversely radiating yellow lines. Adductor muscle scar not very distinct. Protoconch conspicuous on left valve, of one and half whorl, erect and located in the posterior third of the length, shell valves oval, nearly trapezoid, anterior end high, dilated and subtruncate, dorsal margin convex, ventral margin gently curved, hinge narrow and edentulous.

India : Andaman Islands (Port Blair), on *Halimeda opuntia*.

***Julia burni* Sarma, 1975**

(Fig. 38, 7–10)

Shell minute, up to 1.5 mm in length and 1.0 mm in height, cordate, solid, equivalved, porcellaneous and dark brownish-green, hinge with a prominent tooth-like knob on the left valve fitting into a deep socket on the right valve, protoconch on the left valve minute with one and one quarter whorls, sculptured with thin transparent and brownish green periostracum, umbones prominent and beak-like, shell valves broadly oval with rounded anterior margin and deeply excavated posterior margin.

India : Andamans (Port Blair). Indian Ocean : Reunion Is.; Mauritius, Seychelles, Sri Lanka.

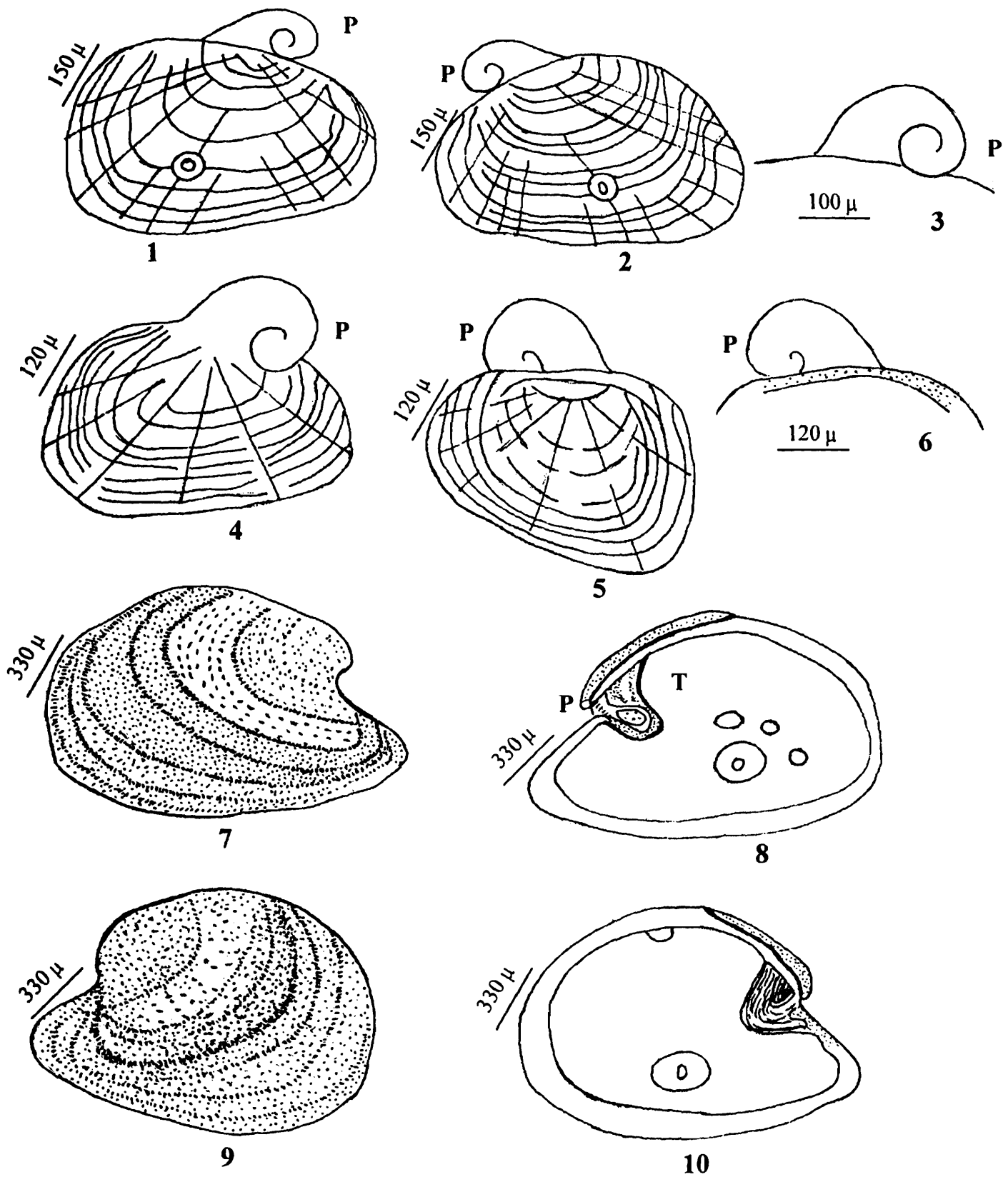


Fig. 38. *Bivalve gastropods* (after Sarma, 1975)

1-3. *Tamanovalva limax*. 1. Left valve; 2. Right valve; 3. Protoconch on the left valve.

4-6. *Tamanovalva schlumbergeri*. 4. Left valve; 5. Right valve; 6. Hinge line of left valve.

7-10. *Julia burni*. 7. Left valve; 8. Inner view of left valve; 9. Right valve; 10. Inner view of right valve.

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Order APLYSIOMORPHA

Animals usually are large. A small calcareous or corneous internal shell covered by mantle is present. A cephalic shield usually is absent. There are two pairs of tentacles, one anterior on the marginal ridges and the other posterior pair known as rhinophores behind the eyes. The latter are curled like rabbit's ears and hence these are commonly called sea hares. Radula is multiserial with a central tooth and numerous lateral teeth. Foot has well developed lateral parapodia directed upwards.

Sexes are united. These are herbivores. It is a small order consisting of two families, namely Aplysiidae and Notarchidae. Both the families are reported from India. The former is more common than the latter and is described below.

Family APLYSIIDAE

Sea Hares

The animals are medium to large in size, often extending up to 200 mm in length. They possess a thin, horny or calcareous internal shell with reduced or rudimentary spire. Cephalic shield is not well defined. Head bears four tentacles, which are cylindrical and flattened. Tentacles resemble hare's ears. Foot is long and narrow. It bears well developed and symmetrical parapodia directed upwards which help in swimming. The animal as a whole is large and humped which on contraction looks like a 'sitting hare', hence called 'sea hare'. Skin is without warts or villi but with reticulate markings. Radula bears a broad central tooth with a denticle and numerous lateral teeth.

Sexes are united. Penis is filiform with a spined sheath. Eggs are laid in gelatinous strings.

The family is divided into three subfamilies, namely Aplysiinae, Dolabellinae and Dolabriferinae. Each subfamily is represented by one genus in the Indian region. Most of the species occur in the intertidal region and a few in the sublittoral region.

Subfamily APLYSIINAE

Aplysia benedicti Eliot, 1899

(Fig. 39. 1–3)

Animal large, up to 100 mm in length and 70 mm in width, body soft and fleshy, elongate-ovoid tapering into a tail posteriorly. Tentacles large and leaf like, rhinophores or posterior pair of tentacles more or less cylindrical. Shell thin, membranous and covered by the mantle, internally

with a thin, white calcareous layer. A ctenidium in a cavity on the right, genital pore anterior to the ctenidium. Radula with a tricuspid central tooth and numerous laterals. Colour greenish black with irregular ocellate spots.

India : Gujarat: Gulf of Kachchh; Tamil Nadu: Gulf of Mannar; Andaman and Nicobar Islands, crevices of rocks. Indian Ocean.

Animal is able to swim rapidly with the help of parapodia. It releases purplish fluid when disturbed and escapes under its cover.

Aplysia cornigera Sowerby, 1876

(Fig. 39. 4–8)

Animal larger than in *A. benedicti*, heavily built, elongate-ovate being narrow anteriorly and broader posteriorly with blunt tail. Anterior tentacles large and flattened, rhinophores short and stumpy with transverse grooves externally giving it a segmented appearance. Parapodia shorter than in *A. benedicti*, fused posteriorly. Shell large, broadly rounded with a beak-like apex. Ctenidium large and bears branched lamellae. Surface with reticulate markings alternating with clear spaces.

India : Gujarat, Lakshadweep, Tamil Nadu: Ennur near Madras, Gulf of Mannar (rare). Indian Ocean.

Subfamily DOLABELLINAE

Dolabella auricularia (Solander, 1786)

(Pl. 94, fig. 8)

Animal very large, up to 200 mm in length. Body oblong ovate, narrow anteriorly and broad posteriorly. Posteriorly part of the body marked by a flattened disc. Skin very rough and tough, bears several filamentous processes. Anterior tentacles flattened and broadly expanded, rhinophores with wrinkled and palliated surface. Foot broad and with a flattened sole. Parapodia well developed and united in front. A ctenidium in the groove. Genital pore posterior to the ctenidium. Radula with numerous close-set teeth. Shell white, thick, calcareous, hatchet-shaped with callous deposit in the apex. When disturbed it releases copious quantity of purplish fluid.

India : Tamil Nadu: Gulf of Mannar (Kundugal Point, Krusadai Island.); Andamans. Indo-Pacific, widely distributed.

It lives under rocks or buried in sand in grass beds or tidal pools. It has a cryptic colouration and not easily noticed.

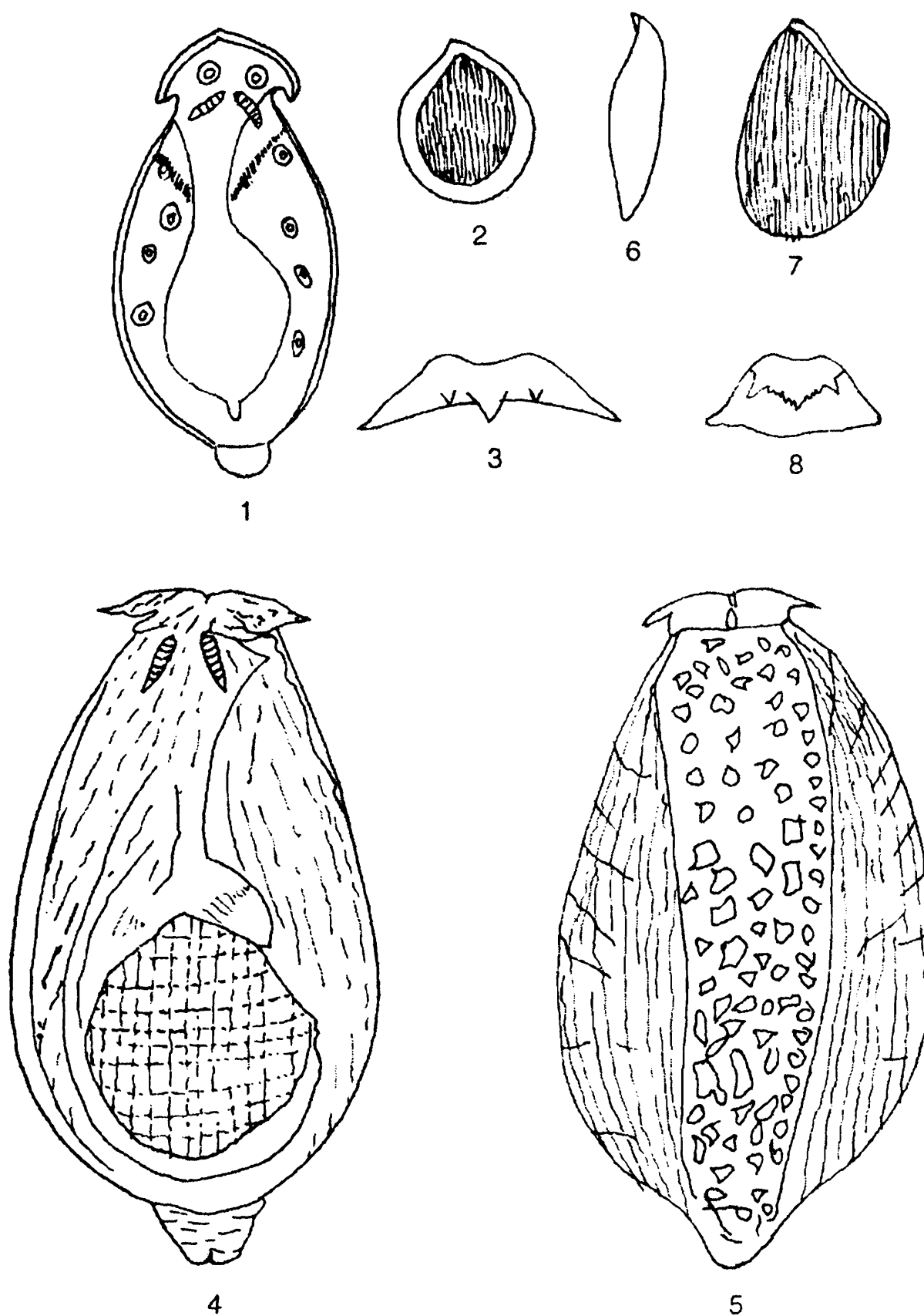


Fig. 39. Aplysiids

1-3. *Aplysia benedicti*. 1. Animal, 2. Shell, 3. Radular tooth. 4-8. *Aplysia cornigera*, 4 & 5. Dorsal and ventral view of animal, 6 & 7. Shell, 8. Radular tooth.

Selected Bibliography

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- Eales, N. B. 1960. Revision of the world species of *Aplysia* (Gastropoda : Opisthobranchia). *Bull. Br. Mus. nat. Hist. (Zool.)*, **5**(10) : 267-404.

Order NOTASPIDEA

It is a less known group in India. Shell may be external, internal or absent. Operculum is absent in adults. The animal is medium to moderately large with ovately elongate body. The radula may or may not have a central tooth, but has numerous lateral teeth. Sexes are united. These are exclusively marine and are epifaunal carnivores.

The order is divided into three families of which two occur in India. One family is dealt with below.

Family UMBRACULIDAE

Umbrella Shell

Shell is external and limpet-like. Apex is central with a spire consisting of one whorled protoconch. Internally there is a circular muscular impression. Head has a pair of tentacles and a pair of rhinophores with slits. Foot is massive and thickened, larger than the shell and without parapodia. Mantle is thin, not covering the entire shell. Mantle cavity is reduced to a groove on the right side and consists of a large, bipectinate ctenidium. Radula is large and broad, with a central tooth and numerous lateral teeth. Sexes are united and monaulic. Penis, situated between the tentacles, is nonretractile.

It is a monogeneric family, with wide distribution in warm temperate and tropical seas. The snails feed on sponges.

Umbraculum umbraculum (Lightfoot, 1786)

(Pl. 94, fig. 6, 7)

Shell external, flat and plate-like, animal cannot be withdrawn into it. Shell remains on the top of the animal like a hump.

India : Tamil Nadu : Gulf of Mannar. Indo-Pacific.

Order THECOSOMATA

Sea butterflies

The shell is tubular or globular. It is thin and transparent. The foot is modified for swimming. It has developed fin-like expansions or epipodia extending from the dorsal side of the head, which is not very distinct. It bears a pair of cephalic tenacles. The animal has an invaginable proboscis. Radula when present has a central tooth and paired laterals. True ctenidium is rarely present. These are protandrous hermaphrodites. These are pelagic occurring in open oceans and has a cosmopolitan distribution.

The members of the order Thecosomata (earlier known as Pteropoda) are commonly called sea-butterflies. Their test is made of aragonite and their presence in sediments of sea bed is used for paleoclimatic interpretation. The occurrence of pteropods is used to examine the Aragonite compensation depth. Pteropod distribution is influenced by temperature and salinity, and they are indicator species of watermass (Meisenheimer, 1948; Sakthivel, 1969). They are important organisms in determining the paleoenvironment (Bhattacharjee *et al.*, 1999). Pteropods are important organisms of late Quaternary sediments around Car Nicobar Island (Nicobars), Narcondum Island (Andamans) etc. As many as 20 species belonging to three families, Limacinidae, Cavolinidae (Euthecosomata) and Peraclididae (Pseudothechosomata) were reported from sediments around Car Nicobar of which 80 % belong to the family Cavolinidae (Bhattacharjee *et al.*, 1999). The planktonic samples are also dominated by Cavolinidae, with the genus *Clio* represented by more number of species (Sakthivel, 1976). Of the 21 species of Pteropods recorded from Indian Ocean, 15 species were from Arabian Sea and Bay of Bengal. *Cavolina gibbosa*, *Cavolina tridentata* were, however, reported only from the sediments around Car Nicobar.

The order is divided into two suborders Euthecosomata and Pseudothechosomata. A total of about 53 species are known, of these 27 species are reported from the Indian Seas.

Suborder EUTHECOSOMATA

Shell spirally coiled with an operculum or bilaterally symmetrical without an operculum, foot develops fins which are separate and dorsal to the mouth. Proboscis is absent. Mantle cavity and osphradium are present. These are hermaphrodites but have separate ovary and testis. The suborder includes two families and both of these are known to occur in India.

Family CAVOLINIIDAE

Shell small, up to 30 mm in length, symmetrical without any coils, fragile and corneous, variable shape, bulbous to flattened triangular, colour white or brown, foot develops dorsal swimming fins or parapodia, head bears unequal tentacles, eyes absent.

Cosmopolitan and holoplanktonic. More than 80% of the species of pteropods reported from seas around India belong to this family.

Following are the species reported from the seas around India.

Family LIMACINIDAE

1. *Limacina bulimoides* (d'Orbigny, 1836) (Saktivel, 1976 – 28% Arabian Sea, 36% Bay of Bengal)
2. *Limacina inflata* (d'Orbigny, 1836) (63% Arabian Sea, 56% Bay of Bengal; Late Quaternary deposits, Car Nicobar)
3. *Limacina trochiformis* (d'Orbigny, 1836) (Bhattacharjee, 1999 – 66% Arabian Sea, 67% Bay of Bengal)

Family CAVOLINIDAE

Subfamily CLIONINAE

4. *Creseis acicula* (Rang, 1826) (Trivandrum, Cochin, Madras, Krusadai)
5. *Creseis acicula acicula* (Quaternary Deposits, Car Nicobar)
6. *Creseis cherchari* (Bows, 1886) (Quaternary Deposits, Car Nicobar)
7. *Creseis virgula* (Rang, 1828) (Sakthivel, 1976 – Arabian Sea and Bay of Bengal, not common)
8. *Creseis virgula conica* Eschscholtz, 1829
9. *Creseis virgula constricta* (Chen and Be, 1964)
10. *Clio cuspidata* (Bosc, 1862) (Bay of Bengal and Arabian Sea, rare)
11. *Clio convexa* (Boas, 1886) (Car Nicobar)
12. *Clio pyramidata* Linnaeus, 1767 (Sakthivel, 1976, Car Nicobar)
13. *Clio pyramidata lanceolata* (Linnaeus, 1767) (Bay of Bengal)
14. *Hyalocylis striata* (Rang, 1828) common in Andaman Sea, Arabian sea, Car Nicobar
15. *Styliola subula* Quoy and Gaimard, 1827 (rare in Bay of Bengal and Arabian Sea, Car Nicobar)

Subfamily CAVOLINIINAE

16. *Cavolinia globulus* (Gray, 1805) Car Nicobar
17. *Cavolinia inflexa* (Lesueur, 1813) (Patchy on East and West coasts, in Andamans predominant in SW monsoon)

18. *Cavolinia longirostris* (Lesueur, 1813)
19. *Cavolinia longirostris longirostris*
20. *Cavolinia longirostris limbata*
21. *Cavolinia longirostris angulosa*
22. *Cavolinia longirostris strangulata*
23. *Cavolinia tridentata* (Forsk., 1773) Southern Indian Ocean, Car Nicobar
24. *Cavolinia uncinata* (Rang, 1829) swarms in eastern Arabian Sea
25. *Diacria quadridentata* (de Blainville, 1827) Moderate in Bay of Bengal and Arabian Sea
26. *Diacria trispinosa* (de Blainville, 1827) moderate.

Suborder PSEUDOTHECOSOMATA

Family PERACLIDIDAE

27. *Peraclis reticulata* (d'Orbigny, 1836).

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- Bhattacharjee, D., Ghosh, S. K., Rakshit, S. and Mallik, T. K. 1999. Evidences of Late Quaternary climatic changes revealed by pteropod records around Car Nicobar Island, Andaman Sea. *Gondwana Geol. Magz. Spl. Vol. 4*(1999) : 157-167.
- Sakthivel, M. 1976. Geographical and seasonal distribution of Euthecosomata (Pteropoda, Gastropoda) in the Indian Ocean. "*Meteor*" *Forsch. Ergebnisse*, 23 : 1-22.
- Meisenheimer, 1949. & Sakthivel, 1969. See Sakthivel, 1976.

Subclass PULMONATA

Shell usually is small to large and of various shapes. It is, however, absent in a few slug-like forms. Operculum is absent except in one marine genus *Amphibola*. Eyes are situated either at the bases or on tips of the tentacles and hence the names Basommatophora and Stylommaatophora respectively. In the former, the tentacles are contractile but non-invaginable, whereas in the latter, they are invaginable. A respiratory pore or pneumostome is present on the right side. Radula bears numerous teeth, a small central tooth flanked on either side by numerous laterals and marginals. Ctenidium is absent but the pallial cavity is modified into a pulmonary cavity. The auricle is placed in front of the ventricle. Nervous system is euthyneurous. Sexes are united, with a single or separate genital ducts. These lay eggs, which hatch out into young ones. There is no veliger larval stage with the exception of a few marine species. Majority of pulmonates are terrestrial except for a few freshwater families (Lymnaeidae, Planorbidae, Physidae, Bulinidae etc.) and a few marine families (Siphonariidae, Amphibolidae etc.).

Traditionally, the subclass is divided into two orders, Basommatophora and Stylommatophora. But recent taxonomic studies have recognized two more orders, Archaeopulmonata to accommodate the family Ellobiidae and Systellommatophora to include shell-less and slug-like forms belonging to the families Onchidiidae, Veronicellidae, Rathousiidae and Rhodopidae. A separate subclass Gymnomorpha has been erected by some to include the last four families. It is again divided into two orders, Systellommatophora for Onchidiidae (marine forms) and Soleolifera for the other three families. Two of these families occur on land, and the third family Rhodopidae is monotypic containing *Rhodope*, which lives interstitially. An unidentified species of the genus was reported from Visakhapatnam, Andhra Pradesh.

Order ARCHAEOPULMONATA

These are primitive pulmonates with a dextrally coiled spiral shell having no operculum. Aperture has strong folds or teeth projecting into it. Tentacles are cylindrical bearing eyes at their bases. Radula has numerous teeth with denticulate central, lateral and narrow marginals. An osphradium is absent. Respiratory opening is present at posterior end of the mantle. Reproductive system is of primitive type with separate genital openings.

The order includes two families Ellobiidae and Otinidae, but only the former has representation in India.

Family ELLOBIIDAE

Shell is small to moderately large in size, up to 60 mm in height. It is thin to thick, ovate to cylindrical in shape. Body whorl is large with a short spire. Aperture is elongate with a thick

outer lip, often reduced in size by the presence of teeth. Columella is with folds or teeth. Outer lip is with one to several teeth. Surface usually is smooth or with striations.

Animal can totally retract into the shell. There is a pair of retractile and rounded tentacles bearing eyes at their bases. Radula has numerous teeth. A small respiratory orifice, pneumatophore, is present on the posterior edge of the mantle. Foot has a small transverse furrow. Sexes are united with separate genital pores. Penis is retractable and has a chitinous stylet.

It is a large family with cosmopolitan distribution and includes about 21 genera and hundreds of species, which occur on land, in estuaries and in intertidal zone of the sea. Some of the species are common in the mangroves of the Indo-Pacific region.

Subfamily ELLOBIINAE

Cassidula nucleus (Gmelin, 1791)

(Pl. 95, fig. 1)

Shell small, up to 25 mm in height, thick and ovate, with a short spire and convex body whorl being angular at the shoulder. Aperture narrow and longer than the spire, columella with callus and two folds, outer lip thickened, obsoletely denticulate and angulate. Surface with irregular spiral striae, fawn coloured.

India : Maharashtra, Tamil Nadu, West Bengal, estuaries and mangroves. Indo-West Pacific.

Ellobium aurisjudae (Linnaeus, 1758)

(Pl. 95, fig. 5)

Shell of medium size, up to 50 mm in height, elongately ovate, spire short, sutures incised. Aperture narrow, columella with callous bearing three folds, the central one large and the one on either side weak, outer lip thickened on its lower two-thirds, no umbilicus. Surface with close-set axial ridges and spiral rows of granules prominent below the sutures.

India : Gujarat, Maharashtra, Orissa: Mahanadi Estuary; West Bengal: Gangetic Delta; Andaman and Nicobar Islands, estuaries and mangroves. Indo-Pacific.

Ellobium gangeticum (Pfeiffer, 1855)

(Pl. 95, fig. 6)

Shell smaller than in *E. aurisjudae*, up to 30 mm in height, fusiformly ovate, thin, covered with straw coloured epidermis, spire short, whorls tumid. Aperture slightly expanded below, columella with two plaits. Surface with thin axial striae.

India : West Bengal, Orissa, Andhra Pradesh. Elsewhere : Sri Lanka, Myanmar.

Pythia plicata (Ferussac) Gray, 1825

(Pl. 95, fig. 7)

Shell small, up to 25 mm in height, ovate, compressed, spire acute, body whorl large, suture impressed, aperture narrow, outer lip margin reflected with three to four plicae protruding into the aperture, columella calloused, with three conspicuous folds, umbilicus deep. Colour light purple with a white band along the outer lip. Sculptured with longitudinal growth striae.

India : West Bengal, Orissa, Tamil Nadu, Pondicherry. Indo-Pacific.

Laemodonta monilifera (H & A Adams, 1854)

(Pl. 95, fig. 2)

Shell small, up to 10 mm, thick, dull, roundly ovate, spire short. Aperture small, with thickened outer lip bearing two stout teeth, columella with three folds, parietal callus well developed, umbilicus obsolete. Surface sculptured with strong, close-set ribs. Colour pale yellowish-brown. Periostracum thin and bears spiral frills.

India.: Orissa, rare. Gulf of Arabia.

Subfamily MELAMPODINAE

Melampus pulchella (Petit, 1842)

(Pl. 95, fig. 4)

Shell very small, up to 8 mm in height, ovately fusiform, solid, spire convexly conoid, whorls six to seven. Aperture narrow, produced at the base, columellar plait strong, outer lip denticulate. Colour light brown, surface with fine growth lines.

India : Maharashtra, West Bengal. Elsewhere : Philippines.

Melampus ceylonicus (Petit, 1841)

(Pl. 95, fig. 3)

Shell small, up to 15 mm in height, ovate with a conical acute spire and a narrow body whorl, suture lineate. Aperture narrowly elongate, oblique and protruding below, outer lip margin thin, inner margin with 6–7 teeth situated in the middle, columella obliquely rounded, with three plaits. Colour light brown, ornamented with dark bands.

India : Maharashtra : Bombay; Andhra Pradesh, Orissa.

The snails are air breathers. These are gregarious and occur under the bark and crevices in the roots of mangrove plants.

Order **BASOMMATOPHORA**

Shell is limpet-shaped or globose and spirally coiled. Operculum is present in the larval stage and in the family Amhibolidae also in the adult stage. Animal is with one pair of tentacles bearing eyes at their bases. These live in or near water and have developed a secondary gill called pseudobranch for respiration. These occur in freshwater, estuaries or in the intertidal rocky shores.

The order includes 15 families of which 6 families are known from India. The following two families occur in marine habitats.

Family **SIPHONARIIDAE**

Shell is small, up to 30 mm in length. It is limpet-like, cap-shaped and irregularly oval in outline. Apex is in the centre or a little posterior. Surface is radially striated or ribbed, either uniformly brownish or with reddish brown flecks. Muscle scar is almost circular and horseshoe shaped and discontinuous on the right broken by pulmonary furrow. Operculum is absent.

Foot is large and rounded. There are no cephalic tentacles. Mantle cavity has a gill posteriorly and an osphradium. Radula has a small and narrow central, with laterals and marginals. Proboscis is short and narrow. Sexes are united, with a common opening on the right behind the head. Male portion has a penis and a prostate. Eggs are laid in ribbons.

The species occur mostly in the intertidal region and browse on the algae. The family consists of four genera and about 75 species. The genus *Siphonaria* has the largest number (70) of species. A few species are reported from India.

***Siphonaria funiculata* Reeve, 1856**

(Pl. 95, fig. 8, 9)

Shell small, up to 15 mm in length, ovate, limpet-like, spire elevated and near to posterior end. Sculptured with radiating ribs and striae, interior smooth, deep groove extends from the centre to right margin, corresponding area on the surface of the shell represented by elevated double ridge, muscle scar impression incomplete and horseshoe shaped. Interior colour light brown, muscle scar white, ribs on the external surface white with light brown interstices.

India : Lakshadweep. Elsewhere : Australia.

Found attached to rocks and tree trunks in the supra tidal zone.

REFERENCE

- Hubendick, B.** 1947. Phylogenie und Tiergeographie der Siphonariidae : Zur Kenntnis der Phylogenie in der Ordnung Basommatophora und des Ursprungs der Pulmonaten Gruppe.
Zool. Bijdr. Uppsala, **24** : 1-216.

Family AMPHIBOLIDAE

Shell is small, up to 25 mm in height. It is globose and spirally coiled with a large body whorl and conical spire. Aperture is large. Umbilicus is conspicuous and wide. Surface is with fine axial striations. Operculum is oval, with a spiral coil and a subcentral nucleus.

Head is large, with short tentacles bearing eyes at their bases or without tentacles. Pulmonary cavity is large, without a gill but with an osphradium. Hypobranchial gland in the roof of the mantle cavity may be present or absent. Sexes are separate. A muscular penis is present. Eggs are laid in capsules and the veliger stage is passed within the capsule.

These live partly buried in the muddy or sandy substratum in sheltered bays, estuaries, backwaters and mangroves. It is a small family with a total of 10 species under two genera, *Amphibola* and *Salinator*. The later genus is represented by one species in the estuaries of India.

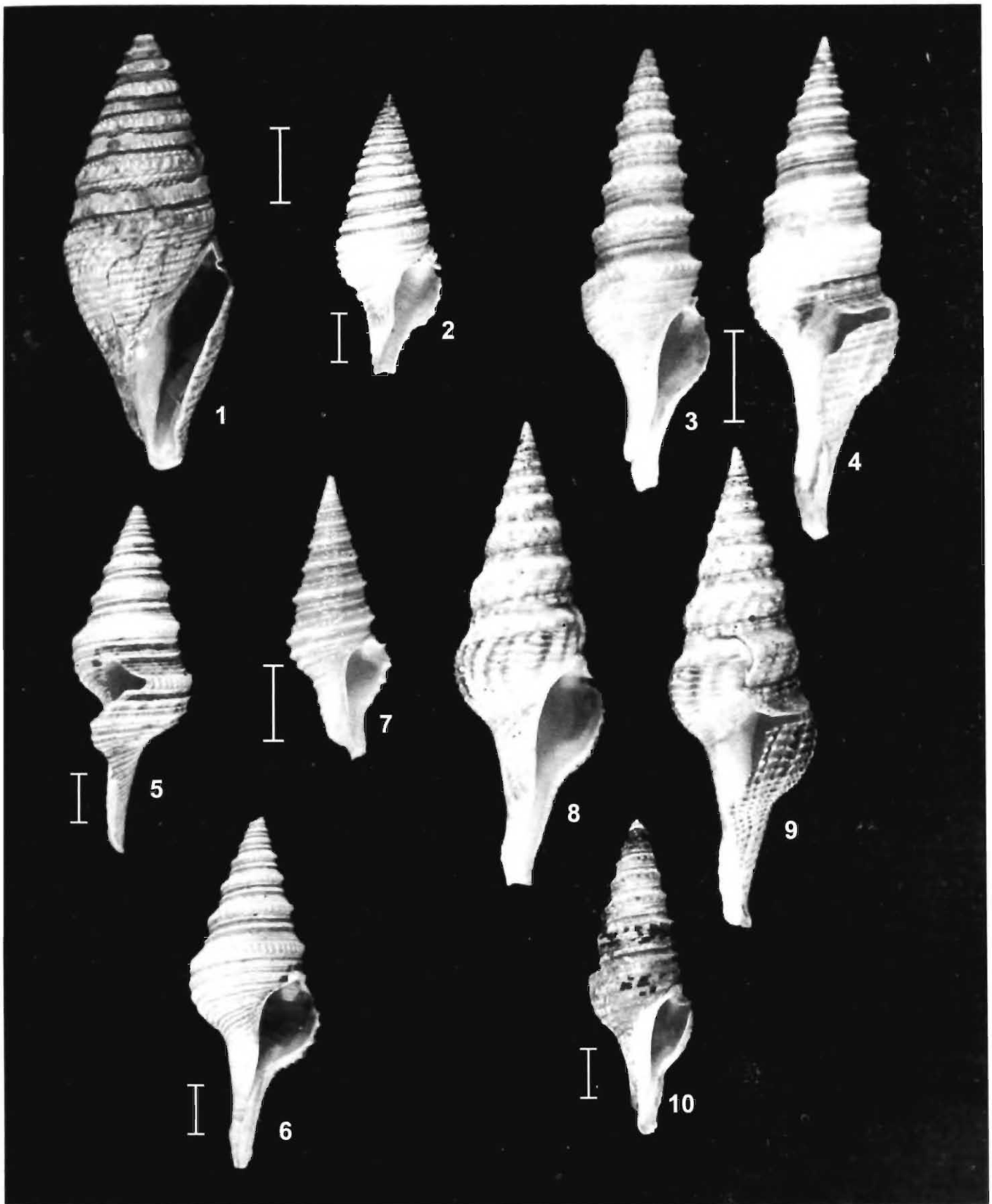
***Salinator burmana* (Blanford, 1867)**

(Pl. 95, fig. 10, 11)

Shell small, up to 30 mm in height, globose, with a large body whorl and a pointed spire, sutures distinct. Aperture large and oval, columella without callus, outer lip thin, without posterior canal, colour dark brown.

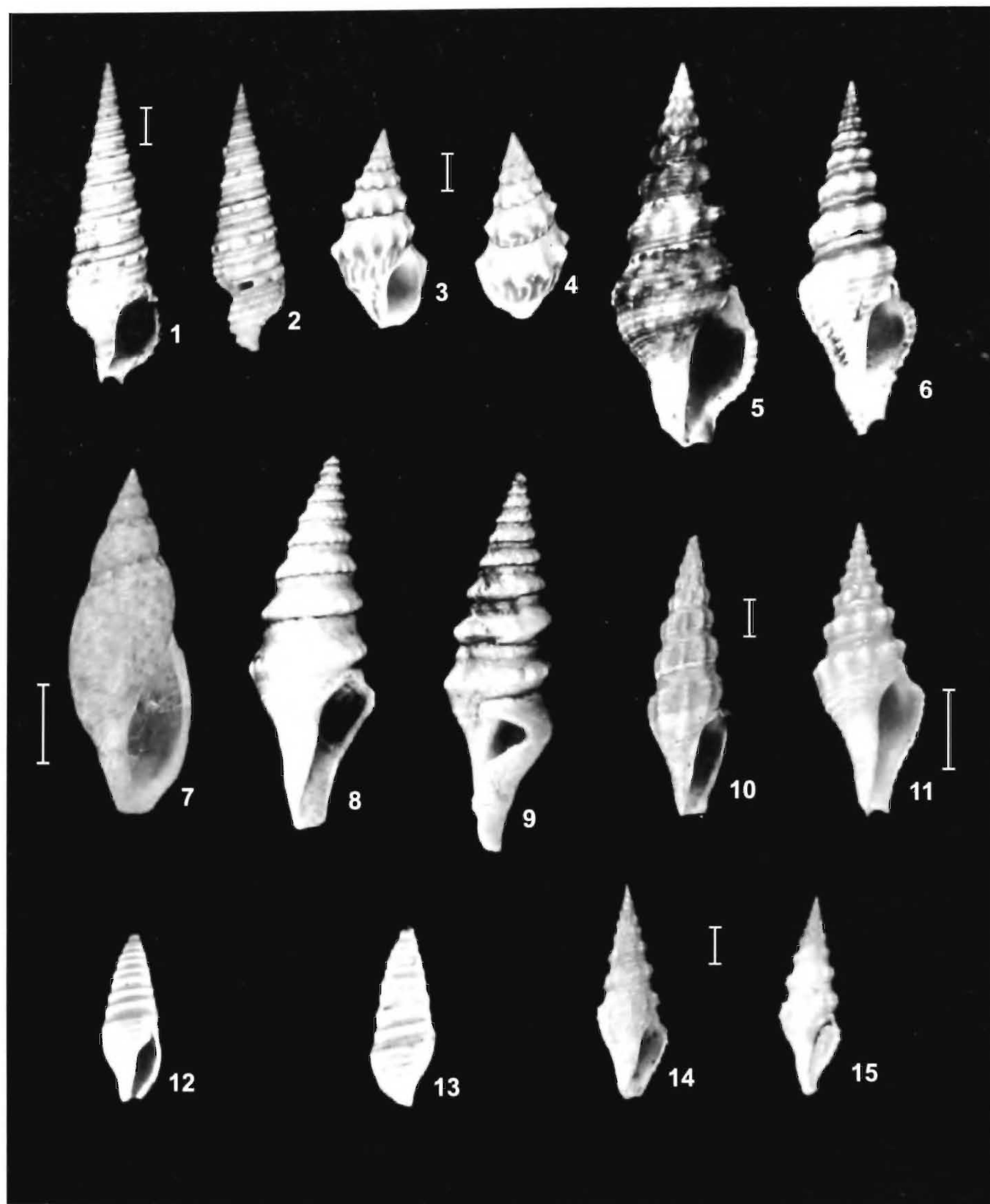
India : Gujarat : Bhavnagar (mangroves); Andhra Pradesh : Kakinada Bay; West Bengal : Gangetic Delta, estuaries and mangroves. Elsewhere : Australia.

Plate 85 : Turridae



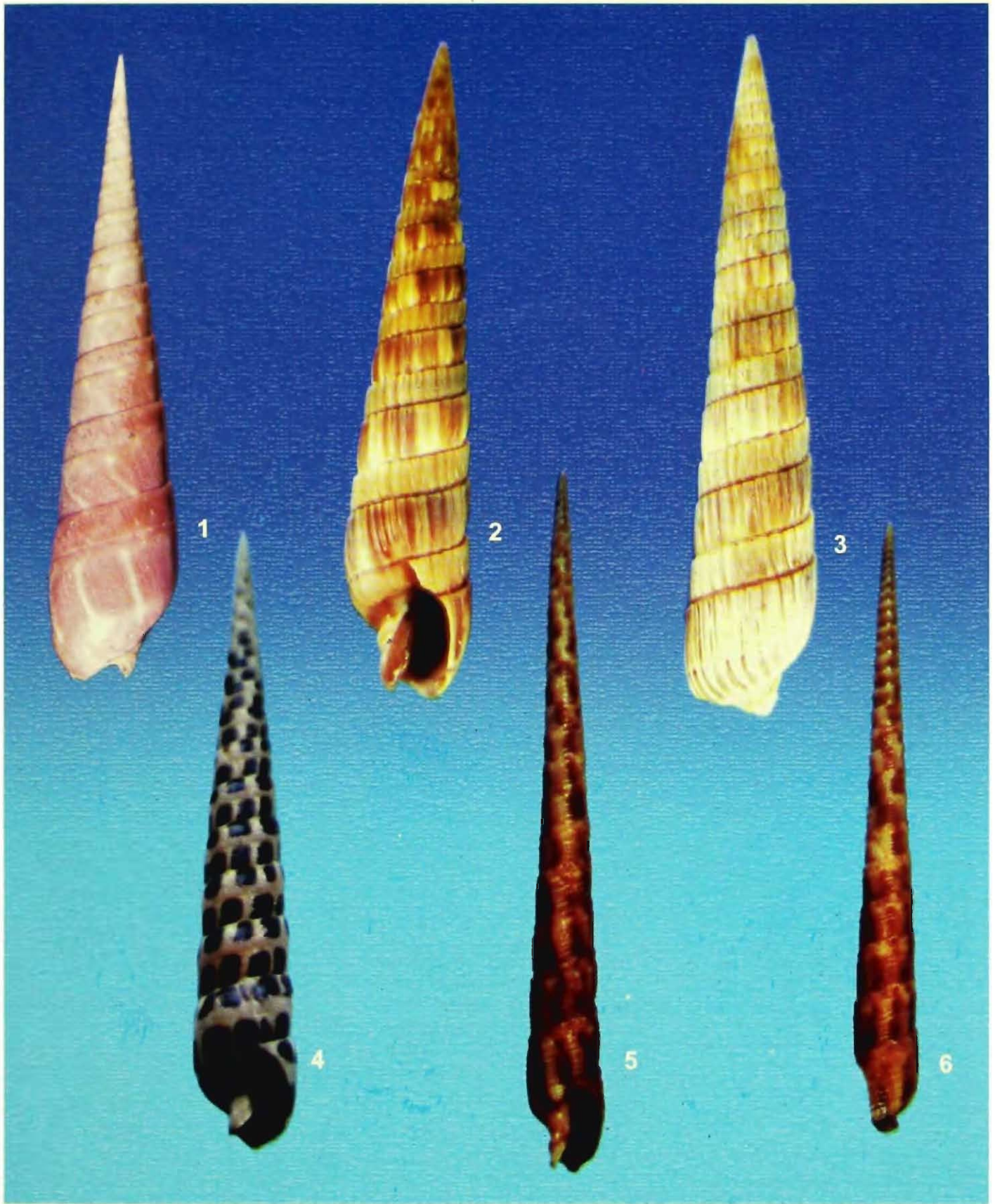
1. *Gemmula oldhami* : Laccadive Sea. 2. *Gemmula congener congener* : Bay of Bengal.
3-6. *Gemmula vagata* : 3776/1. 7. *Gemmula monilifera*; 8,9. *Unedogemmula unedo*; 10. *Gemmula speciosa* (*Tomopleura vertebrata*).

Plate 86 : Turridae



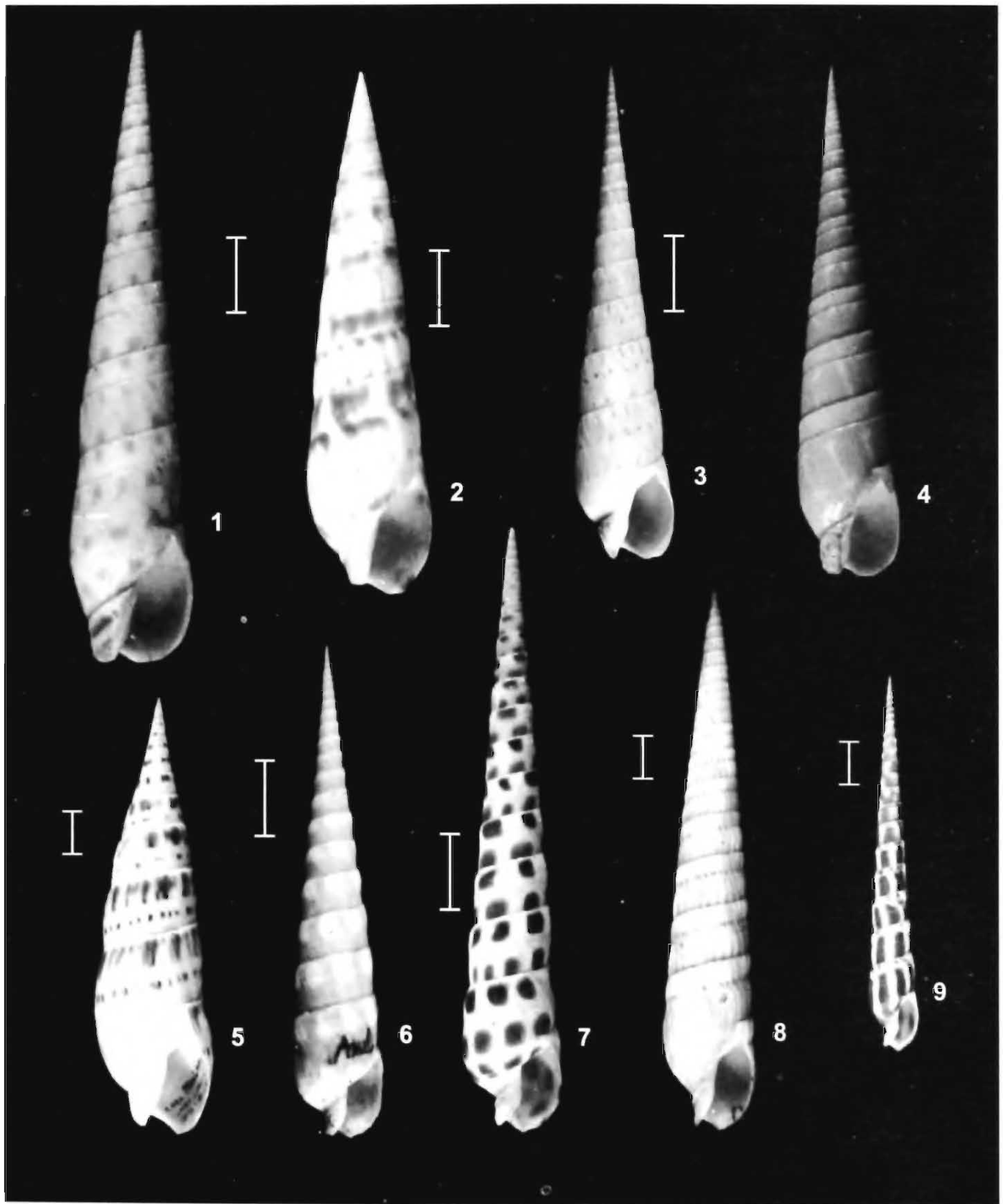
1,2. *Xenuroturrus cingulifera cingulifera*; 3,4. *Austroclavus exasperatus*; 5. *Funa flavidula*; 6. *Ptychobela nodulosa*; 7. *Daphnella lymnaeiformis*; 8,9. *Lucerapex indagatoris*; 10. *Drillia fugata*; 11. *Ptychobela griffithii*; 12,13. *Turridrupa bijubata*; 14,15. *Funa tayloriana*.

Plate 87 : Terebridae



1. *Terebra dimidiata*; 2,3. *Duplicaria duplicata*; 4. *Terebra subulata*; 5. *Terebra commaculata*.

Plate 88 : Terebridae



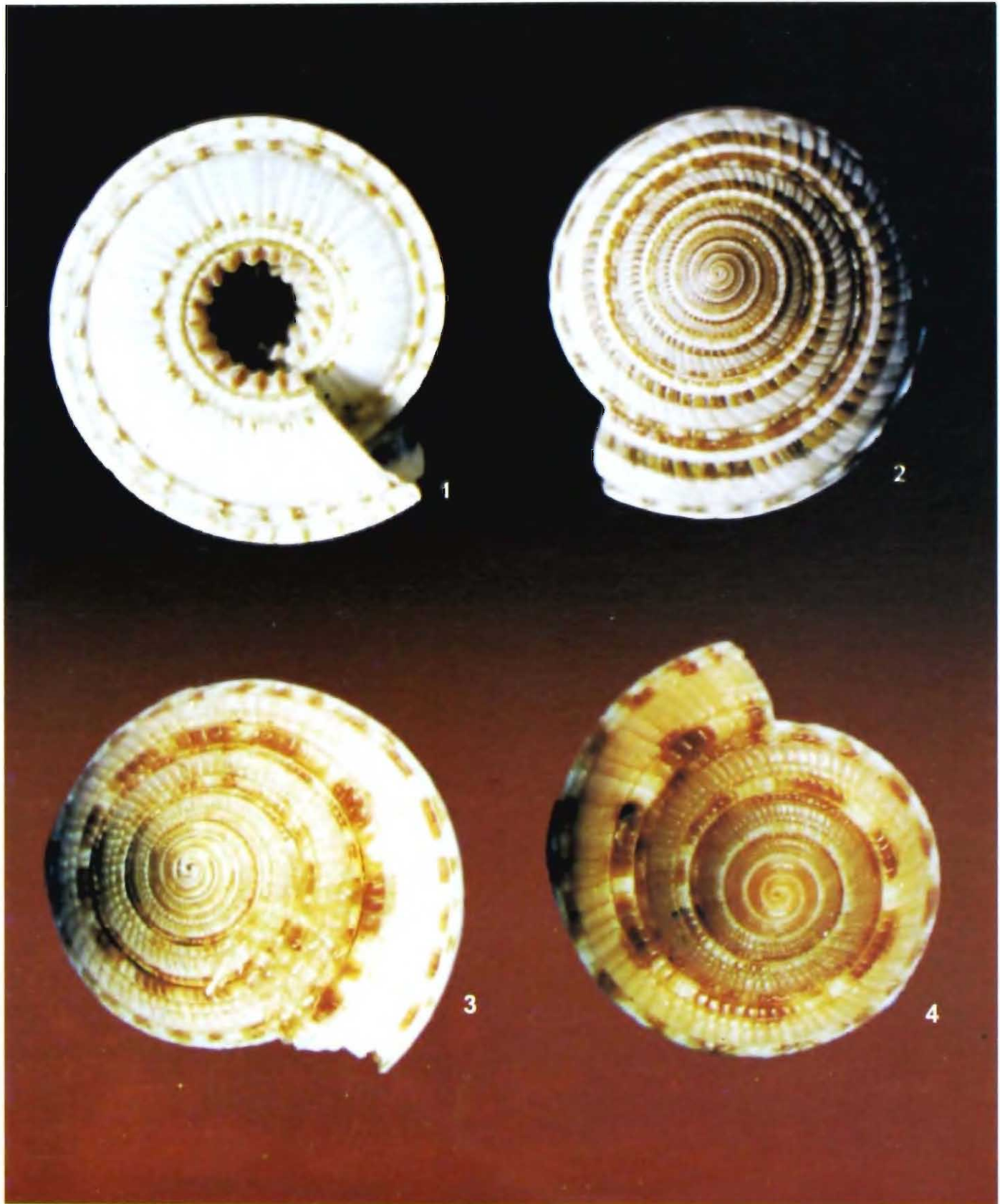
1. *Terebra areolata*; 2. *Terebra chlorata*; 3. *Terebra crenulata*; 4. *Terebra dimidiata*; 5. *Terebra maculata*; 6. *Terebra guttata*; 7. *Terebra subulata*; 8. *Terebra nebulosa*; 9. *Terebra commaculata*.

Plate 89 : Terebridae



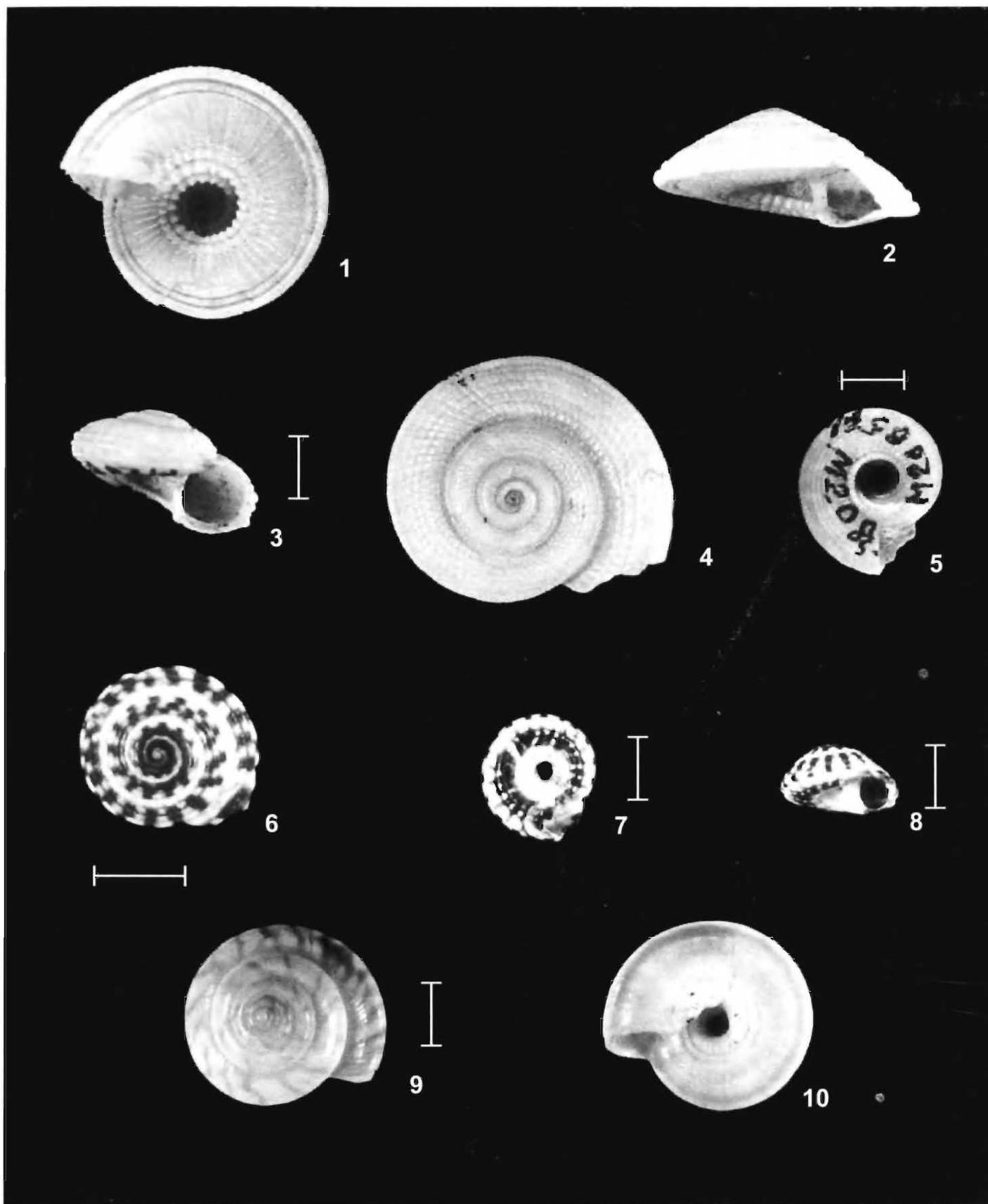
1. *Hastula inconstans*; 2. *Terebra columellaris*; 3,4. *Hastula traillii*; 5. *Impages hectica*
6,7. *Duplicaria duplicata*; 8,9. *Hastula lauta*.

Plate 90 : Architectonicidae



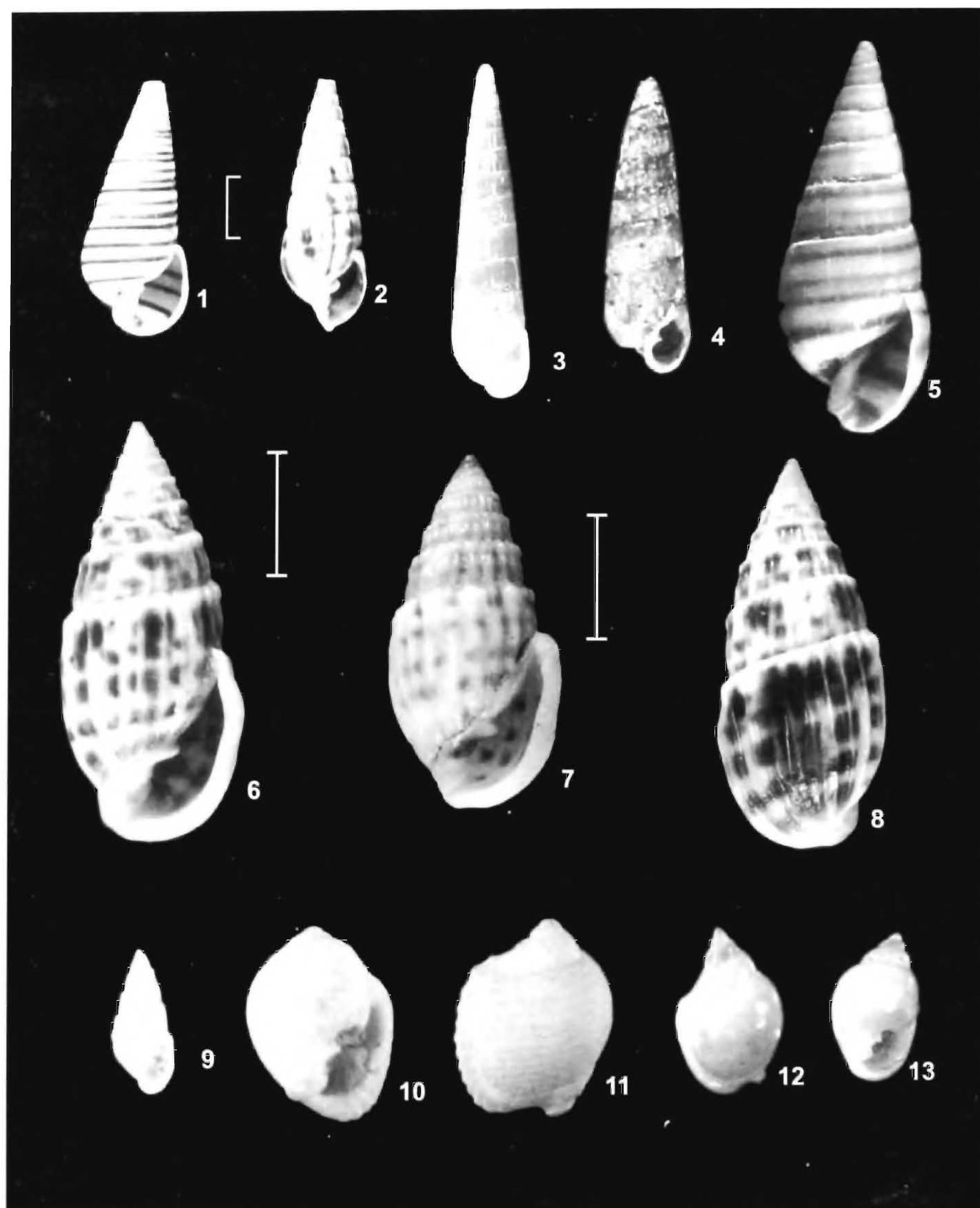
1-3. *Architectonica perspectiva* ; 4. *Architectonica laevigata*.

Plate 91 : Architectonicidae



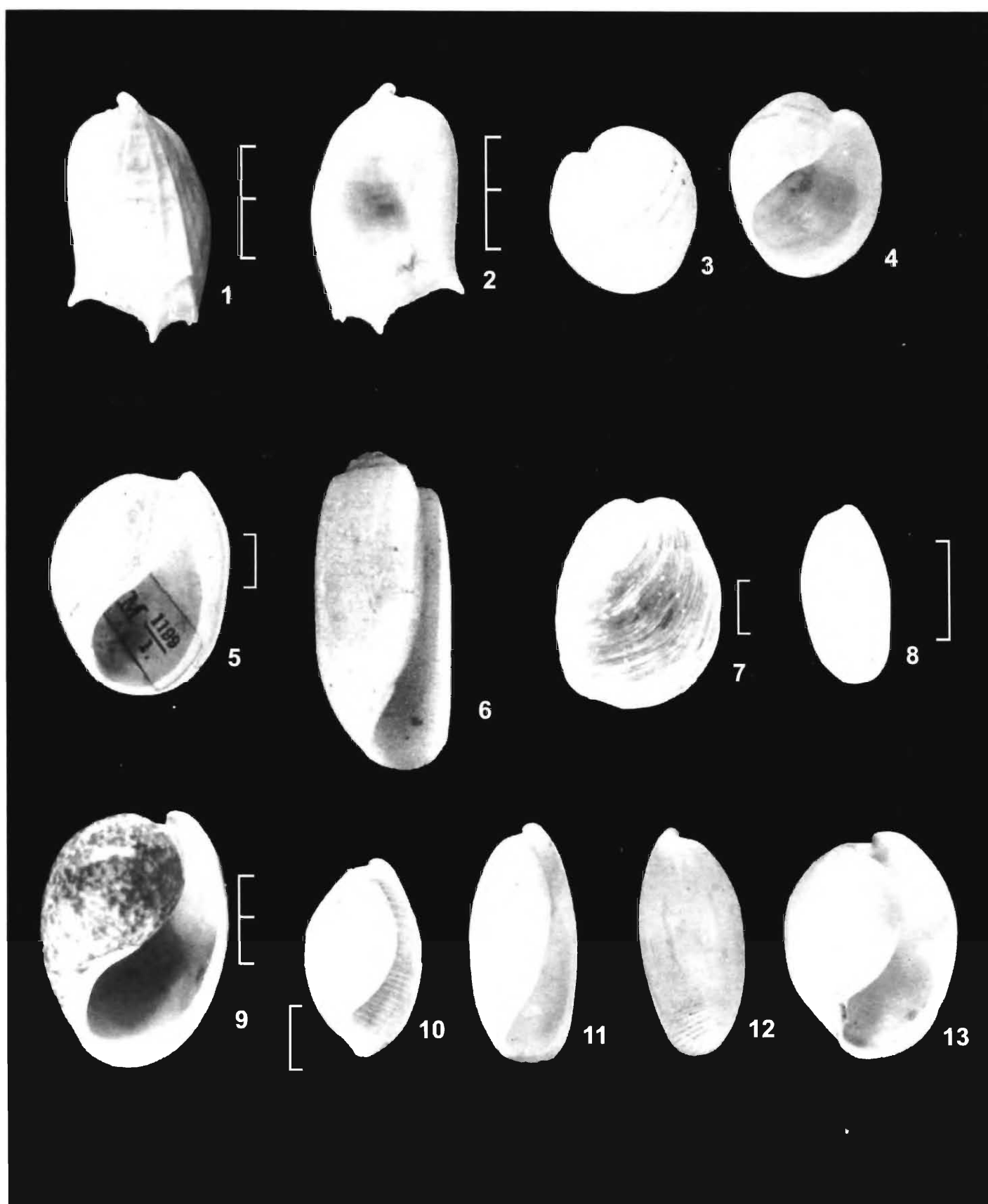
1,2. *Architectonica perspectiva*; 3-5. *Heliacus stramineus*; 6-8. *Heliacus areola*;
9,10. *Philippia radiata*.

Plate 92 : Pyramidellidae



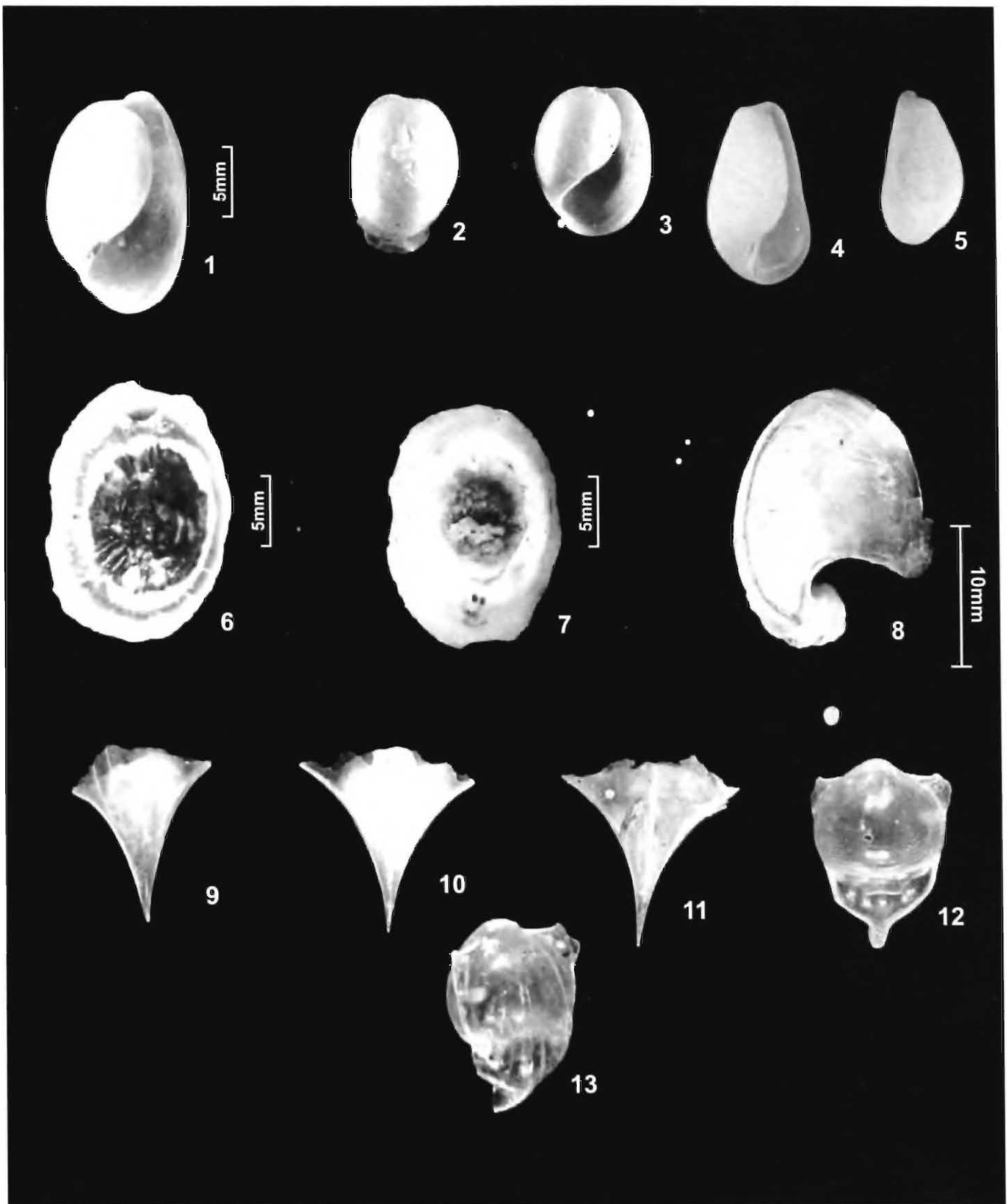
1,2. *Pyramidella dolabrata terebellum*; 3. *Turbonilla felicitas*; 4. *Syrnola dubiosa*; 5. *Pyramidella sulcata*; 6-8. *Otopleura auriscati*; 9. *Odostomia babylonica*; 10,11. *Ringicula encorpoferans*; 12,13. *R. propinquans* *Odostomia oxia* x.

Plate 93



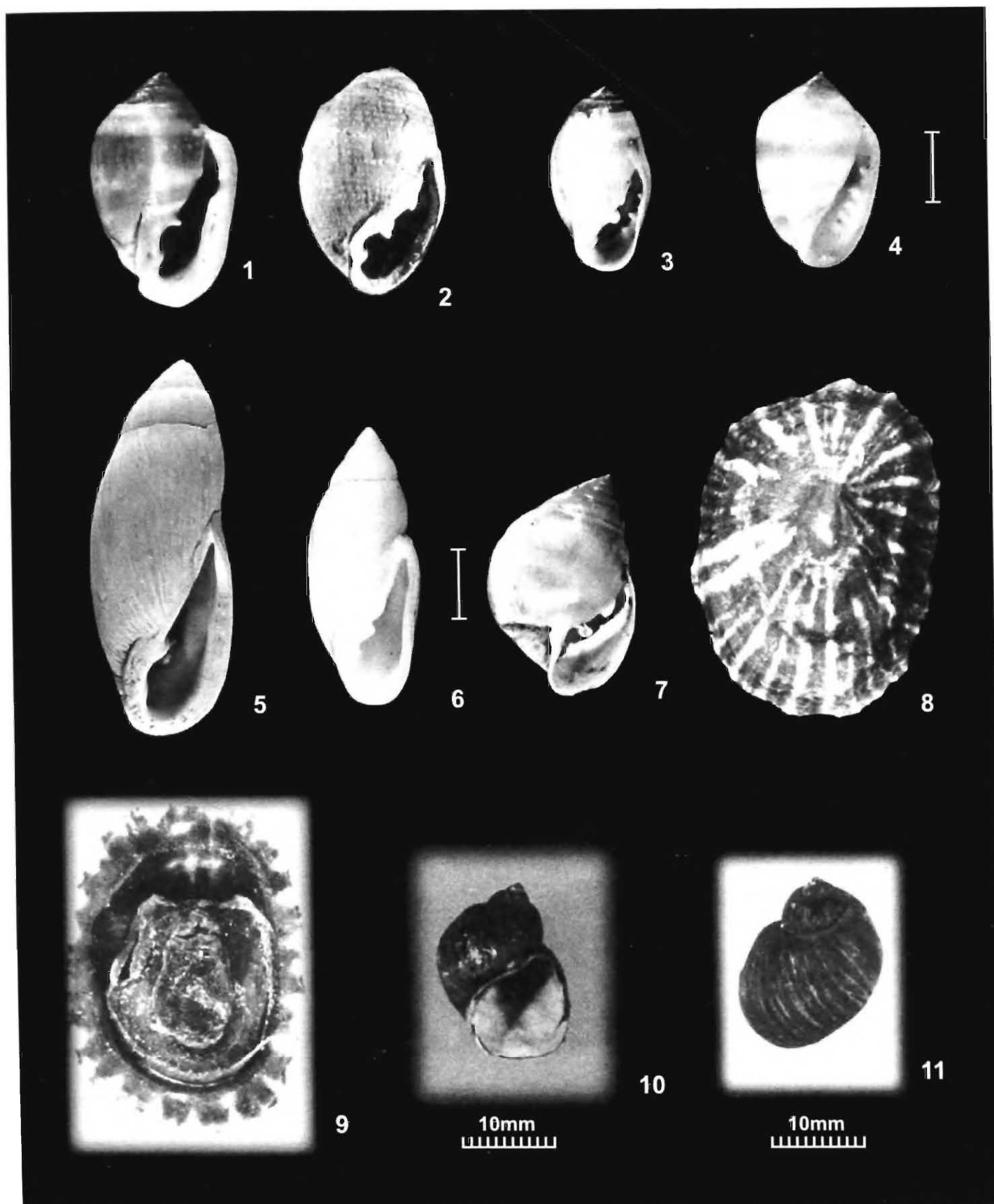
1,2. *Amathina tricarinata*; 3,4. *Hydatina velum*; 5. *Scaphander andamanicus*; 6. *Tornatina inconspicua*; 7. *Philine aperta*; 8. *Atys cylidricus*; 9. *Bulla ampulla*; 10 *Atys hyalina*; 11,12. *Atys elongata*; 13. *Atys naucum*.

Plate 94



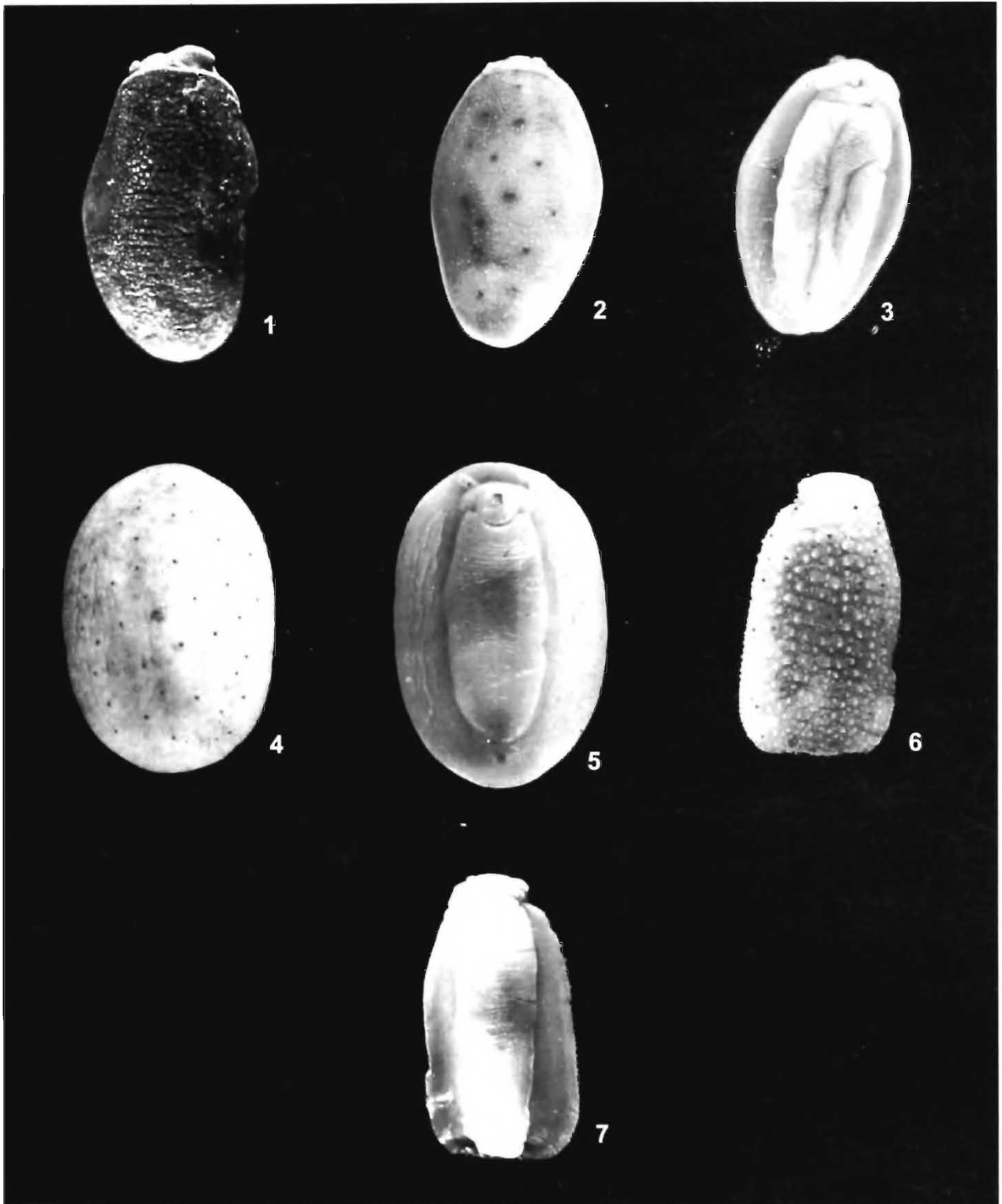
1. *Haminea elegans*; 2,3. *Haminea crocata*; 4,5. *Retusa pyramidata*; 6,7. *Umbraculum umbraculum*; 8. *Dolabella auricularia*; 9. *Clio pyramidata*; 10,11. *Clio cuspidata*; 12,13. *Cavolinia longirostris*.

Plate 95 : Ellobiidae, Siphonariidae



1. *Cassidula nucleus*; 2. *Laemodonta monilifera* : Orissa; 3. *Melampus ceylonicus*; 4. *Melampus pulchellus* 5. *Ellobium aurisjudae*; 6. *Ellobium gangeticum*; 7. *Pythia plicata*; 8. *Siphonaria funiculata*.

Plate 96 : Onchidiidae



1-3. *Onchidium tenerum*; 4-5. *Onchidium tigrinum*; 6-7. *Onchidium typhae*.
All from Sunderbans.

Order SYSTELLOMMATOPHORA

A shell is absent. Animals are slug like with an elongately ovate body. They vary in size from microscopic to 100 mm in length. Mantle is thick forming a notum dorsally and extending anteriorly down over the head and laterally along the length of the body. There are two pairs of tentacles on the head, the upper ones contractile and bear eyes, the lower ones are tactile. The respiratory pore and anus are located at the posterior and behind the foot. Radula possess unicuspid teeth. Two separate genital openings are present; the male opening lies anteriorly on the right side of the head and the female opening is midway on the right side or near the anus.

The order is treated by some under a separate subclass Gymnophora or Opisthopneumona (See Boss, 1982). The order contains one family, which is represented in India.

Family ONCHIDIIDAE

Animals usually are slug-like, large and shell less. Dorsal surface is covered by thickened mantle. It usually is uneven with papillae or tubercles and accessory eye like structures. The mantle has repugnatorial glands, which release repulsive secretions. Head has a roof like frontal shield. The body is divided into dorsal notum separated from the lateral hyponotum or girdle-like border by a groove called perinotum. Foot is large and broad with a median sole. Radula is broad with a tricuspid central tooth and numerous lateral and marginal teeth.

Sexes are united, with a posteriorly located female genital pore and an anteriorly situated male gonopore. The penis has an accessory gland. A coiled shell is present in the embryonic stage. A pelagic veliger larva is present.

These are amphibious, occurring mainly in estuaries. *Onchidium* having Indo Pacific distribution is the only genus reported in India. It is represented by seven species in India (Awati & Karandikar, 1948; Stoliczka, 1869).

Onchidium tenerum (Stoliczka, 1869)

(Pl. 96, fig. 1–3)

Animal of moderate size, 35 mm in length and 19 mm in width, ovate-elongate, flabby. Mantle not tough, greenish grey, ornamented with dark spots and fine granules, eye pedicles with swollen base and distinctly swollen granular tips, eyes black and located in transverse folds. Anus pulmonary orifice and female genital pore located at the posterior end of the mantle on the ventral side.

India : West Bengal; on the banks of the river Hugli. It remains buried in the mud with its posterior end pointed upwards. It was found crawling on the dykes and poles after rain. It is a common species in the Hugli estuary.

***Onchidium tigrinum* Stoliczka, 1869**

(Pl. 96, fig. 4, 5)

Animal small, 17 mm in length and 13 mm in width, ovate, with hard coriaceous mantle, body pale greenish with irregular spots, surface with large black-tipped tubercles enclosing granules in between, head and tentacles dark green, tentacles stout at the base, thin in the middle and slightly thickened at the tip bearing black eyes. Anus, pulmonary orifice and female genital pore located at the posterior end on the ventral surface.

India : West Bengal; on the banks of Hugli-Matla estuary, in shady places, inside crevices of dykes, bricks etc.

***Onchidium typhae* (Buchanan, 1800)**

(Pl. 96, fig. 6, 7)

Animal large, 44 mm in length and 20 mm in width with both ends obtuse. Mantle greenish and ornamented with various shades, dorsal surface with numerous small and large tubercles bearing 2 to 4 black spots on their tips. Foot broad.

India : West Bengal, Hugli-Matla estuary. Its range in the estuary extends to about 120 km up stream and occurs on the muddy substratum and on erected structures.

***Onchidium verruculatum* (Cuvier, 1830)**

(Fig. 40. 1, 2)

Animal largest of all species, 50 mm in length and 30 mm in width, elongately ovate with very tough and leathery integument. Dorsal surface covered with tough and warty tubercles varying in form, size and structure, tubercles may be simple or compound, the latter in a group of 5–7 simple tubercles, tubercles in the posterior region irregularly branched and bushy in appearance known as “gill trees”, unbranched tubercles with free and flattened ends bearing eyes called “ocular papillae” situated on four-fifths of the dorsal surface. Head large and rounded bearing a vertical slit-like mouth on its ventral surface, with two widely separated cephalic tentacles. Animal dirty greyish and ornamented with dark purplish brown blotches on the dorsal surface and pale yellowish grey on the ventral surface. Foot with pale greenish sole and hyponotum surrounding it dark greyish green.

India : Common on east and west coasts and Andaman and Nicobar Islands. Occurs in the nooks and crevices of rocks in the intertidal region. It is the only species occurring in the rocky marine environment.

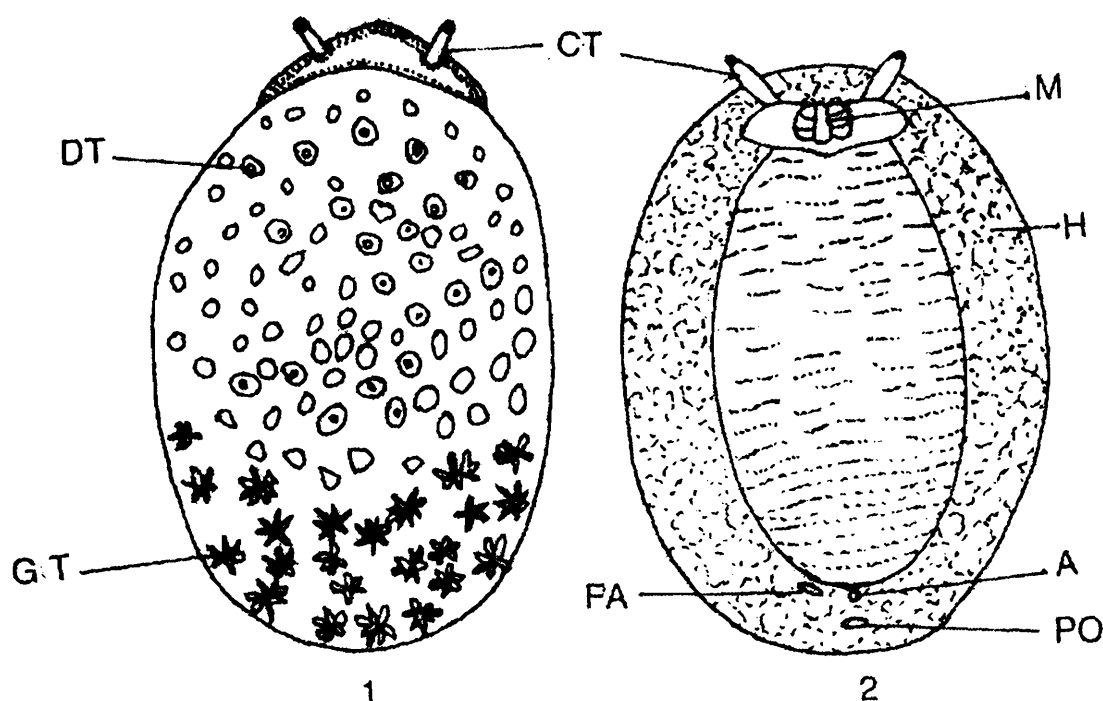


Fig. 40. *Onchidium verruculatum*

1. Dorsal view, 2. Ventral view. A-anus; CT-cephalic tentacle; DT-dorsal tubercle; FA-female genital pore; GT-gill tubercle; H-hyponotum; M-mouth; PA-pulmonary aperture.

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5. GLOSSARY

Acuminated. Apex of shell terminating in a point

Anal canal. In gastropods channel at the posterior end of the lip through which the animal passes waste matter. Hence also known as posterior canal.

Anterior. In bivalves, it is the side on which the head, or part analogous to the head of the animal lies, It is known in the shell by the umbos, which if turned at all, are turned towards that part of the anterior. In spiral univalve is that part of the outer lip which is at the greatest distance from the apex. Of a conical univalve such as a limpet it is the part where the head of the animal lies.

Apex. The posterior tip of shell, first formed part of shell.

Apophysis. A projecting peg-like or finger-like structure.

Arcuate. Arched

Auricles. Ear-like extension of dorsal region of shell commonly separated from the body by a sinus. *Adj.* Auriculate.

Auriform. Earshaped

Auricular aura. Blunt internal ridges swelling out distally as low tubercles, marking lower border of auricles.

Biangulate. Two keeled or with two ledges (shelf-like projections).

Bicarinate. Having two keels or ledges.

Bidentate. Two-toothed

Body whorl. The largest whorl of a spiral shell (anterior)

Buccal cavity, Cavity within the mouth

Callus. A deposit of enamel, mostly around the aperture in gastropods; thickening layer of shelly material. *adj.* Callous.

Callosity. Callus; the state of being hardened with a shelly deposit.

Canal. A groove which characterize some spiral univalve shells, where the inner and outer lips unite at the front or posterior part of the aperture.

Canaliculate. Channelled or grooved.

Cancellate. Marked by ridges or cords crossing each other (sculpture lines intersecting at right angles)

Carina. Keel

Carinated. Having a raised, thin ledge; keeled

Clathrate. Latticed; crossing to form a network

Clavate. Club-shaped

Clypeiform. Shield-shaped.

Columella. The column formed by the inner sides of the volutions of a spiral univalve. It is sometimes described as the inner lip of the aperture of which it forms a part (the axis of coiling of a tightly spiral gastropod).

Columellar lip. The inner edge of the aperture, including that part of it which covers the body whorl.

Concentric. A term applied to sculpture which is spiral

Cord. Small, round-topped ridge

Cordate/Cordiform. Heart-shaped

Coriaceous. Resembling leather

Coronate. Having the whorls of a spiral shell surrounded by a row of spines or tubercles

Costae. Ribs

Costated. Ribbed

Crenate. Having the edge cut or notched

Crenulate. Finely notched.

Decollated. Apex broken off

Decussated. Intersected by striae crossing each other (with a latticed surface formed by the intersection of fine ribs, not necessarily at right angles)

Dextral. Coiled in a right-hand spiral

Dioecious. Sexes separate

Direct Development. No larval stage in development, young ones in adult body form released.

Dorsum. Hump or upper surface (applied to cowry shells). Back of the shell opposite the aperture.

Emarginate. Indented at the edge

Entire. Uninterrupted, not emarginated. The pallial line in bivalves is entire, when continued without interruption or without a sinus and the peristome of a univalve is said to be entire when not interrupted by canals or by the body whorl.

Exsert. Protrude; Projecting.

Fasciole. A spiral band formed by the successive edges of a canal (either anterior or posterior) indicating growth stages in a gastropod.

Fossula. Shallow linear depression on the inner lip, especially in cowries.

Fusiform. Shaped like a spindle, swelling in the centre and tapering at the extremities.

Funicle. A ridge of callus spiraling into the umbilicus in the naticid gastropods.

Gibbous. Hump backed

Glabrous. Bald, smooth, possessing a surface without hair or any unevenness.

Globose. Rounded like a globe or ball

Granose. Granulated

Granulose. Granulated or covered with minute grains

Growth-lines. The lines formed by the edges of the successive layers of shelly matter deposited by the animal as it increases the shell. Also called growth striae.

Height. Distance from the apex to the base or anterior end of the shell. Also known as length.

Hermaphroditic. The presence of male and female reproductive systems in the same individual. Protandric, when the male system appears first and functions; simultaneous when both the systems are present.

Indirect development : Development passes through a larval stage

Imbricated. When the superficial laminae are placed over each other like tips of shingles.

Imperforate. Without umbilicus

Inflated. Swollen; applied to round shells of thin texture.

Inner lip. Edge of the aperture of a univalve shell which is near to the imaginary axis, as distinguished from the outer lip or that which is on the opposite side. (Also called columella lip).

Interstices. Narrow spaces between things closely set

Incised. Sculptured with one or more sharply cut grooves.

Keel. A flattened ridge, resembling the keel of a ship. (A carina or outstanding rib, usually marking an abrupt change of slope in the shell outline).

Labial area. Area around the inner lip or labium from the anterior part of the columella to the suture.

Labiate. With a thickened margin.

Lamella. A thin scale or plate.

Lamellate (adj.). Covered with thin scales or plates.

Laminar tooth. A plate-like structure

Lineated. Marked with lines.

Linguiform. Tongue shaped

Lip. Edge of the aperture, inner lip or labium, outer lip or labrum

Lirae. Striate

Lirate. Referring to threadlike sculpture.

Mamillated. Applied to a univalve shell when the apex is rounded like a teat; bluntly rounded.

Nacre. Mother-of-Pearl. Inner layer of shell

Nacreous. Pearly; the shell consisting of thin layers of aragonite parallel to inner surface of shell showing luster.

Node. Small knob

Nodose (adj.). Having tubercles or knobs

Nodule. Small node (adj. nodulose)

Nucleus. The first formed part (of a shell or operculum).

Obtuse. Blunt or rounded

Oliviform. Shaped like an olive-shell

Operculum. The plate with which many molluscs close the aperture of their shell when retracted inside.

Ossicle. An accessory shell plate or protuberance

Outer lip. The edge of the aperture at the greatest distance from the axis.

Oviparous. Egg laying

Ovoviviparous. Producing young by eggs hatched with in the body, nourishment of embryo is from the yolk of egg.

Papillary/Papillose. Shaped like a teat.

Parietal whorl. Broader upper part of inner lip in a univalve shell.

Paucispiral. Few whorls in the spiral, generally applied to the operculum.

Pelagic. Free Swimming

Penultimate whorl. The last whorl but one (anterior) of a spiral shell.

Periphery. Widest part of a whorl

Periostracum. The thin, horny outermost layer of the shell

Peristome. Edge of aperture

Pilose. Hairy, covered with hairs

Plait. A fold. A term applied to the prominence or folds on the pillar or columella lip of some univalve shells.

Planorbid. Coiled in a flat spiral

Plica. Plait or fold on the columella of gastropods. adj. plicate

Plication. A fold, especially on the columella of gastropods.

Posterior. The side known by the direction of the curve in the umbos, which is from the posterior towards the anterior. Posterior of univalve opposite end to the anterior (mouth).

Prodissoconch. Shell secreted by larva or embryo, which is preserved as beak of some adult shells (Embryonic shell; the umbo in a bivalve).

Protoconch. Embryonic shell, whorls at the top of a shell in gastropod

Prismatonacreous. The shell consisting of prisms of aragonite parallel to inner surface of shell showing luster.

Pyriform. Pear-shaped

Punctate. Dotted with small spots or depressions

Pustule. Small rounded elevation smaller than a tubercle

Quadrante. Square, applied when the outline of shells is formed by nearly straight lines meeting at right angles.

Quadruplicate. With four folds or plaits—applied to the columella of some shells.

Radiating. Applied to the ribs, striae, or bands of colours when they meet in a point at the umbos of a bivalve shell and spread out towards the ventral margin.

Reticulate. Resembling net work. See cancellate

Rostrate. Beaked or pointed at the end, usually the anterior end of bivalves.

Rostrum. A beak like process or extension

Rugose. Rough, rugged.

Sagittate. Shaped like an arrow-head.

Sensu lato (S.I). In the broad sense.

Sensu stricto (S.S). In the strict sense.

Shoulder. Angulation of a whorl forming the outer edge of sutural ramp.

Sinuate. Having a wavy edge.

Sinus. A deep indentation; cavity

Siphonal fasciole. A spiral roughened tract to the left of the aperture in gastropods, formed by successive growth stage of the anterior canal.

Siphonal canal. A groove in the shell through which the siphon is extended. Also known as anterior canal.

Spermatheca. A seminal receptacle, a chamber in the female reproductive system for the reception and storage of sperm.

Spermatophore. A package of sperm formed within a specialized part of the male reproductive system.

Spatula. Spoon-shaped area surrounded by the muscle scar of limpets.

Spire. Includes all the volutions above the aperture of a univalve shell, except body whorl or last whorl.

Striae. Fine incised groove, either flat or raised, which cross the surface of shells in different directions.

Striated. Marked with fine grooves or lines (Fine sculpture that has the appearance of microscopic scratches or grooves)

Subsutural. Just under the suture

Subulate. Slowly tapering to a sharp point; applied to shells which are long and pointed as in genus *Terebra*.

Sulcus. A slit or fissure.

Sulcated. Grooved or furrowed.

Sulci. Grooves or furrows

Suture. The line which marks the joining of the whorls of the spire.

Tessellated. Applied to the colouring of shells, when arranged in regular defined patches like a tessellated pavement.

Transverse aperture. At right angles with the axis of the shell

Tubercle. Small rounded elevation, larger than a pustule, smaller than a nodule.

Turreted. When the whorls of a spire are regulated so as to have the appearance of little turrets rising above each other.

Varicose. Bearing one varix or more

Varix. A projecting ridge formed by the thickened, reflected edge of a former aperture, after increased growth of the shell.

Vitreous. Resembling glass.

Whorl. A complete turn or revolution around the imaginary axis of a spiral shell.

Width. Widest part of a shell at right angles to its axis. Also known as breadth.

6. TAXONOMIC INDEX

Synonyms are given in italics, subgenera in parentheses and higher taxa in all capitals.

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7. ADDENDUM

LIST OF MOLLUSCS INCLUDED IN THE SCHEDULE OF WILDLIFE (PROTECTION) ACT 1972

The following molluscs are included in the schedule of Wildlife (Protection) Act 1972 by a notification dated 5.12.2001 :

Part IV B – Mollusca

1. *Cassis cornuta*
2. *Charonia tritonis*
3. *Conus malneedwardsi**
4. *Cypracasis rufa**
5. *Hippopus hippopus*
6. *Nautilus pompilus*
7. *Tridacna maxima*
8. *Tridacna squamosa*
9. *Tudicla spiralis**

2. In Schedule IV to the said Act, after serial number 18 and the entries relating there to, the following serial numbers and entries shall be added, namely :

19. Mollusca

- (i) *Cypraea lamacina**
- (ii) *Cypraea mappa*
- (iii) *Cypraea talpa*
- (iv) *Fasciolaria trapazium**
- (v) *Harpulina arausica**
- (vi) *Lambis chiragra*
- (vii) *Lambis chiragraarthritis**
- (viii) *Lambis crocea**
- (ix) *Lambis millepeda*
- (x) *Lambis scorpius*
- (xi) *Lambis truncata*
- (xii) *Placenta placenta*
- (xiii) *Strombus plicatus sibbaldi*
- (xiv) *Trochus niloticus*
- (xv) *Turbo marmopratus**

Comments

3. Correct spelling *Conus milneedwardsi*

4. *Cypraecassis*

6. *Nautilus pompilius*

9. *Tudicla spirillus*

19.(i) *Cypraea limacina*

(iv) *Fasciolaria trapezium*

(v) *Harpulina arausiaca*

(vii) *Lambis chiragra arthritica*

(viii) *Lambis crocea*. No such species. It may be *Tridacna crocea* of the three species of *Tridacna* known from India two are included (Nos. 7 & 8). *Tridacna crocea* is the third species

(xv) *Turbo marmoratus*

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